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An Abrupt Awakening

With the outbreak of hostilities in Europe the first world-wide industry to pay an involuntary and heavy toll was maritime commerce. Following the immediate closing of exchanges in the world's markets, the virtual blockade of the immense merchant fleet of Germany and the partial embargo of oversea commerce at the seaports of belligerent nations, ship owners, exporters, producers, manufacturers and merchants of neutral countries were brought to the sudden realization of the vast importance of an independent merchant marine, adequate in size and equipment to meet the needs of the nation to which it belongs. With the rapid advances that have been made in recent years in the development of means for ocean transportation, the whole world has become so interwoven with the sinews of commerce that scarcely a nation exists, no matter how remote, whose people have not become dependent for the continuance of their prosperity and welfare, in one way or another, upon the interchange of commodities with foreign nations. In the United States, where for a generation the majority of its ninety million people by the expression of their will in the halls of Congress have firmly resisted any attempts of far-sighted statesmen to establish an adequate foreign merchant marine, the awakening in the present crisis has been abrupt and is bound to be far-reaching.

Effect of War on Shipping

While the ultimate effect of the war on shipping will depend upon its duration and cannot be foretold, nevertheless its immediate effect has been destructive. The immense German merchant fleet, which comprises about 11 percent of the world's tonnage, has been literally swept from the high seas. Many of the large British and French ships, together with a considerable proportion of their officers and crews, have been withdrawn for war service. At the time of writing, a total of 82 vessels, mostly steamers, of which 63 are German, 8 are Austrian, 6 are British, 2 are Servian and 1 is Finnish, have been seized as prizes of war, while several merchant vessels, including the big German liner *Kaiser Wilhelm der Grosse,* have been destroyed. At the outbreak of war, with financial and commercial conditions reduced to the lowest limits by the closing of exchanges and derangement of credits, foreign commerce was virtually brought to a standstill. In the large seaports of neutral countries hundreds of men, such as stevedores, longshoremen, shippers and the crews of small harbor craft, all dependent upon shipping for their livelihood, were thrown out of employment. As the first shock of war passed over, however, readjustment began. Through the influence of Great Britain's enormous sea power, traffic across the Atlantic and through the Mediterranean became reasonably safe. The assumption of war insurance risks by the English and French governments aided greatly in paving the way for the resumption of foreign commerce in English and French vessels. Under war conditions, however, both the nature and volume of exports and imports of belligerent nations are radically changed. The domestic resources of combatants must be conserved, the inflow of necessary supplies assured, and the export of staples and manufactured products seriously curtailed. Simultaneously, however, an extraordinary opportunity is given to neutral nations to acquire a large share of the world's trade, hitherto carried on by the belligerent nations. In the present instance, in the United States especially, the call from South America, the Orient and also from the warring nations for staple and manufactured products, foreshadows a commercial future for the country far greater than has ever been presented before. While the bulk of the world's sea-going tonnage is still available for commerce, and will in time be accessible owing to the diminished volume of foreign commerce from the countries involved in war, nevertheless it is clearly evident that the chances for the United States to grasp this extraordinary commercial opportunity would be tremendously enhanced by the existence of an American merchant marine adequate in size to deal with an immediate expansion of its commerce across the seas regardless of hostilities in foreign countries.

Emergency Measures

Although immediate steps were taken in the United States to deal with the precarious situation created by the partial suspension of foreign commerce and the consequent congestion of export goods at the Atlantic seaports, very little actual progress has as yet been made in solving this complex problem. The most important action taken so

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far is the enactment of a law admitting to American registry for overseas trade foreign ships bought and owned by American citizens or corporations. This is a step in the right direction, but in itself is ineffectual and unlikely to add much sea-going tonnage to the American merchant marine until a thorough revision of the United States navigation laws has been made and such restrictions removed as at present make the cost of operation of American ships so much greater than that of vessels flying foreign flags. Under the law as passed, the President is authorized to suspend at his discretion for such length of time as he deems desirable certain provisions of the navigation laws relating to the requirements for officers and crews of American ships, the eligibility of foreign officers for service on such ships, and also certain provisions relating to the measurement and inspection of American vessels. Until the administration has made known its definite decision in this respect, ship owners will be forced to postpone any changes of registry which they may contemplate. If the action of the administration is favorable, it is probable that a hundred or more American ships flying foreign flags will speedily be transferred to American registry, including many of the ships owned by W. R. Grace & Company, the United States Steel Corporation, the Standard Oil Company and the United Fruit Company. It is fortunate that the provision in the above measure as originally proposed, to admit foreign built ships to the coastwise trade of the United States, was decisively defeated. Such a course of action would have been extremely detrimental to the shipbuilding and steamship interests in the country and imposed upon them unnecessary hardships. Another emergency measure which seems both desirable and necessary is now under consideration in Congress which provides for the establishment of a Bureau of War Risk Insurance to cover American cargoes and American ships. Its purpose is to assume the war risk on vessels flying the American flag or carrying American cargoes whenever it is impossible for the ships or cargoes to get insurance from private companies on equality with vessels of other countries which issue war insurance. It is not intended that the Government shall compete in any way with private companies engaged in general marine insurance, and the Bureau of War Risk Insurance will be discontinued as soon as hostilities cease. Other proposals have been made, providing for government ownership of vessels for foreign trade, but so far these proposals are not looked upon with favor, because it is held that such a course will not only discourage private enterprise from entering the shipping field, but will also be harmful to American shipping in general and prove of little permanent value. It is highly desirable that any steps which are taken to improve the American merchant marine should be of permanent and lasting value and provide a basis on which a merchant marine can be developed on a paying basis as the foreign trade of the country expands.

The American Merchant Marine

One of the most important proposals that has yet been made in connection with plans for restoring the American merchant marine in foreign trade is the recommendation, widely indorsed by shipping and steamship interests, for the establishment of a permanent advisory board or council composed of men thoroughly experienced in shipping and steamship affairs to serve in the same capacity as the marine departments of the British and German boards of trade. Such a branch of the Federal government would be competent to deal intelligently and efficiently with provisions for merchant shipping—something which past experience has shown that a poorly advised and partisan Congress cannot be expected to do.

Hitherto Congress has allowed the navigation laws of the United States to become so encumbered with burdensome restrictions that it has been impossible for American ships to compete successfully with more cheaply operated vessels of other nations. For this reason the emergency measure admitting foreign built ships to American registry cannot prove effectual until the navigation laws have been thoroughly revised and American ships placed on a more equal footing with the merchant fleets of other nations. While some relief in this direction will be given shortly by the powers invested in the President to suspend temporarily certain provisions of the navigation laws, yet something more radical and far-reaching is required before the future of the American merchant marine is assured. For this purpose the creation of an advisory board such as has been outlined would be of inestimable value not only in revising the present laws, but also in laying the foundation for the future regulations on which a new American merchant marine can be built.

Among the provisions in the existing laws which place unnecessary burdens on American ship owners are the requirements for larger crews, for a number of officers in excess of that required by other nations, for a system of measurement by which the tonnage of American ships is far greater than that of ships under foreign flags, with consequent higher port charges, and certain regulations regarding the inspection of both hulls and machinery which impose further burdens without increasing the safety of the vessels. The rules which require adequate quarters and conveniences for the crew, which regulate the hours of employment and provide improved sanitary conditions, are praiseworthy features and have been brought about through painstaking endeavors to secure adequate protection for seafaring men and the general public dependent upon their work.

As to the tentative proposals for government-owned ships to meet the exigencies of the present emergency and to form the nucleus of a future foreign merchant marine, so far as plans of this nature have as yet been disclosed, the objections raised in all quarters seem to outweigh any benefits that might accrue for such a

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scheme, although further disclosures may throw a different light on the question. The most insistent objection, that such a procedure might involve the United States in complications with some of the belligerent nations during the war, either through the purchase of vessels owned by the belligerents or through the transportation of contrabands of war, and thus impair the strict neutrality of the nation, is too important to be lightly thrown aside.

Liverpool Dock Improvements

The tendency of all foreign ports to adopt similar terminal plans, as well as the same methods of freight handling, is of great interest. Formerly, as there were no accepted rules, each port engineer usually followed out his own ideas. While most ports on the Continent had practically agreed that certain designs were the best, Liverpool remained the exception.

On July 2, 1914, the Mersey Docks and Harbor Board of Liverpool adopted a large scheme of dock improvements which will cost $1,102,262 (£226,000). The chairman of the Board stated that the plan will be a new departure for Liverpool, in that the shed will be set back from the water's edge with space for two lines of car tracks and for the rails of the cranes. It was thought by the majority of the members of the dock board that, as this principle is in active operation in so many ports, it would be well for them to have it at Liverpool. The shed will be 150 feet wide, 1,500 feet long, located on the South Quay of the new Gladstone Dock No. 1. There will be an equipment of twelve electrical discharging cranes on the dock side and ten electrical loading-off cranes on the road side.

Liverpool was almost the only progressive port remaining which continued to build sheds close to the quay's edge and to build expensive sheds to house in railway tracks or dray space which it is now determined should be outside the shed. The old plans of shed construction prevented the installation of the best types of freight handling machinery. Outbound cargoes arriving in cars must be trucked from the cars to the edge of the pier, and also that portion of inbound freight not requiring assorting, which could have been swung to the cars by one movement, must also be trucked.

In general, it may be said that the plan now adopted by the majority of marine terminal engineers is to design the piers or quays of sufficient width so that there can be two or three lines of railway tracks or a roadway between the shed and the quay wall, with additional tracks or a roadway to the rear of the shed. The transshipment shed should have sufficient capacity so that there can be temporarily stored, if necessary, the whole cargo of a ship opposite the ship's berth. This shed holding capacity can be obtained by adding to the width or height by mechanical high tiering or by using several stories. Where it is not possible to have surface track connections, there should be a dray space between the shed and the water, and service can be obtained by motor or horse drays in the place of the railway cars.

This position taken by the Mersey Docks and Harbor Board should prove instructive to port commissions in the United States.

Propelling Machinery of the Nevada

The propelling machinery of the United States battleship *Nevada*, whose launch at the Fore River shipyard was recorded in our last issue, consists of an improved type of Curtis turbines, placed in four watertight compartments, arranged for twin screws. These turbines are designed to develop 26,500 shaft horsepower at 222 revolutions per minute. Each line of shafting is driven by a high-pressure turbine in the forward compartment, and a low-pressure turbine in the after compartment. Each high-pressure turbine is connected to its low-pressure unit by a 28-inch diameter exhaust pipe. In the after end of each low-pressure turbine there is built in a reversing turbine which exhausts through the common exhaust pipe to the condenser.

On the forward end of each high-pressure turbine shaft there is located a cruising turbine with reduction gear. These cruising turbines are designed to develop 2,750 horsepower at 3,200 revolutions per minute. The reduction gear has a ratio of 23.3 to 1, and thus drives the main propeller shaft at 137 revolutions per minute, which corresponds to a cruising speed of 13½ knots. The reduction gear is connected to the main turbine shaft by means of a clutch easily operated from the working platform. The main bearings and horseshoes for thrust bearings are provided with forced lubrication and water service.

The auxiliaries, consisting of condenser, air pumps, feed tanks, main circulating pumps, feed water heaters, etc., are located in the engine rooms. The condenser and air pumps are designed to maintain, under full power condition, a vacuum of 93 percent of absolute.

Arranged forward of the engine rooms are three firerooms, each containing four watertube boilers of the Yarrow type, designed for oil burning by mechanical atomization in the burners. The boilers are designed for a pressure of 295 pounds gage, which drops to 265 pounds gage at the main turbines.

The fuel oil system consists of the necessary piping, together with pumps, heaters, etc., each boiler being fitted with an emergency automatic shut-down valve in case any breaks in the fuel oil piping should occur.

The air for combustion is furnished by forced draft blowers, discharging air into the firerooms, which are of closed stoke-hold type. The blowers are designed to maintain the maximum rate of combustion, the number of revolutions not exceeding 1,050 per minute.

The machinery of the *Nevada* is noteworthy in that it is the first installation of high-speed geared turbines for cruising purposes on a United States battleship, and because of the opportunity it affords for comparison with a sister ship propelled by reciprocating engines.

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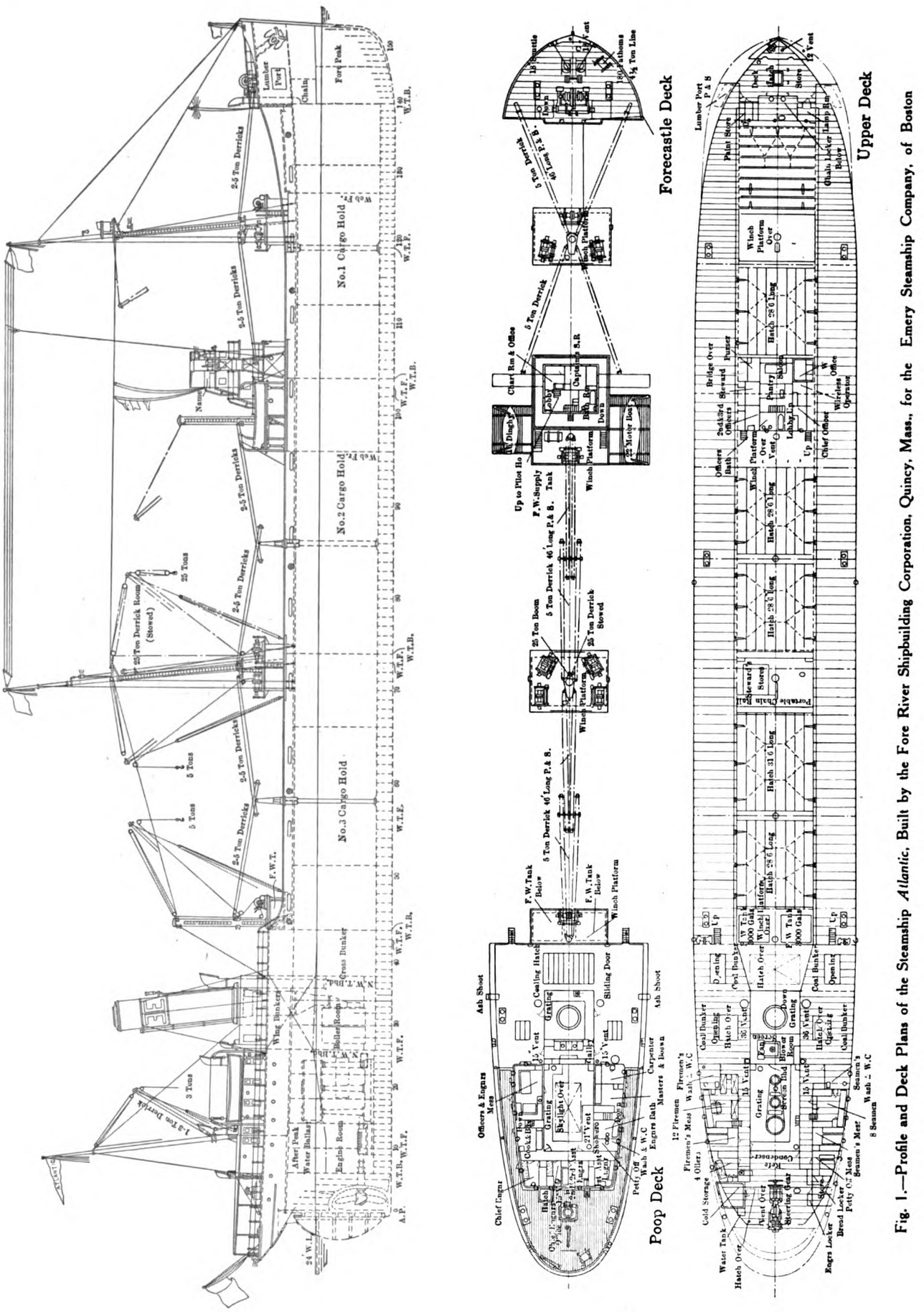

Fig. 1.—Profile and Deck Plans of the Steamship *Atlantic*, Built by the Fore River Shipbuilding Corporation, Quincy, Mass., for the Emery Steamship Company, of Boston

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New Freighters for the Panama Canal Trade

Description of the Freight Steamers Atlantic and Pacific, Just Completed by the Fore River Shipbuilding Corporation for the Emery Steamship Company

The steamship *Atlantic,* whose plans are reproduced herewith, is one of the two sister steamships recently completed by the Fore River Shipbuilding Corporation of Quincy, Mass., for the Emery Steamship Company of Boston to the designs and under the supervision of Mr. George Simpson, naval architect, New York city. The *Atlantic* has embodied in her design a number of new features with a view to the special trades in which she will be engaged, namely, as a bulk carrier or as a lumber carrier. The principal dimensions are as follows: Length overall, 405 feet 9 inches; length between perpendiculars, 388 feet; breadth, molded, 54 feet 4 inches; depth, molded, 31 feet 8 inches; load draft, 24 feet 9 inches; deadweight capacity, 9,000 tons.

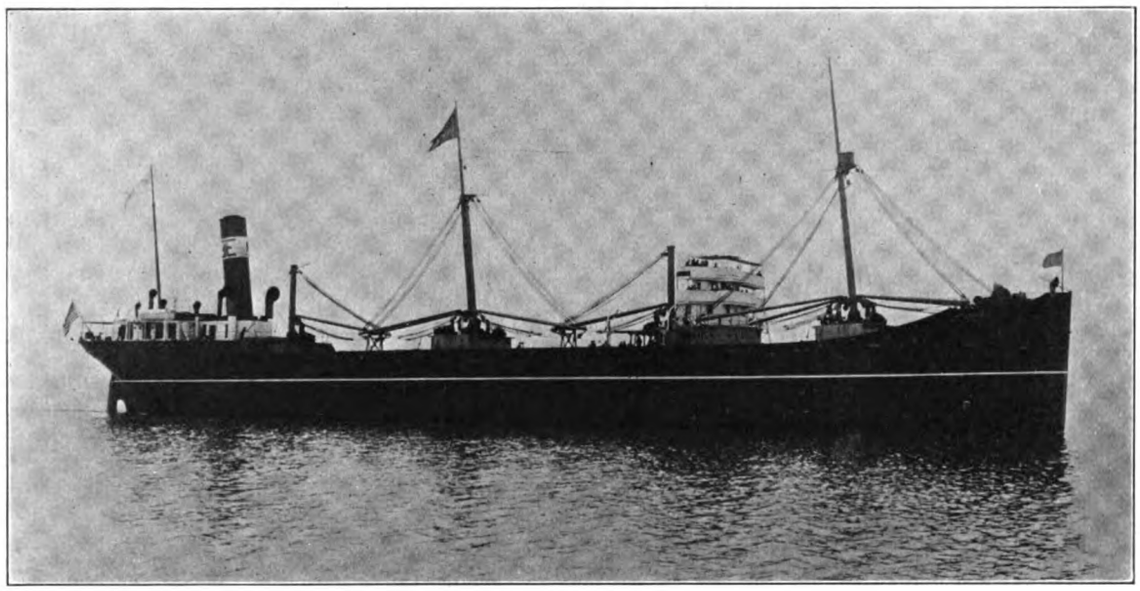

Fig. 2.—Bulk Freight and Lumber Carrier *Atlantic*

The Emery Steamship Company ordered these vessels specially for their Boston-Seattle trade via the Panama Canal, and in view of being employed on the eastward run in the lumber trade, special consideration has been given to stowing lumber cargo in long lengths, as well as shipping the longest sticks of Douglas fir carried as a deck load. In this connection this vessel is a striking commentary on the regulations at present under consideration in England, Germany and Spain, with a view to determining the advisability or otherwise of permitting vessels engaged in the lumber trade to carry deck loads. Americans conversant with the lumber trade believe strongly that vessels constructed for carrying deck loads, such as have been in operation on the Pacific coast for many years, ought not to be disbarred from carrying these loads in the manner which experience has demonstrated to Pacific coast operators as being safe and sane, namely, that sufficient stability be given the vessel to carry a superimposed load with special arrangements for securing that load so that it cannot change in any contingency likely to be experienced.

An examination of the *Atlantic's* plans will show that this feature has been specially taken care of in the preparation of the design, as the three large holds into which the vessel's hull proper is divided have been constructed without any obstructions whatever, enabling the hold cargoes to be efficiently and economically stowed. For the deck load, provision has been made by making not only the midship quarters in the form of an inland house, and by similarly constructing the forecastle, enabling long spars to be shipped through the large lumber ports in each bow and passed along the deck for an unobstructed length of 300 feet. The island feature of these two erections, together with solid boatswain storehouses at the base of each mast, affords a splendid support to the lateral movement of the deck loads, which, in combination with the Pacific method of securing the load, when properly stowed on deck by chains secured to the sheerstrake and passed over the load from side to side with turnbuckles to take up the slack, results in building a deck load which has all of the stability and homogeneity of an erection itself.

The *Atlantic* has been constructed on the familiar type of American freight vessels, with the propelling machinery located aft and the remainder of the hull forward of the machinery space devoted entirely to cargo carrying purposes. The cargo holds are three in number, each 90 feet in length, the construction being on the deep frame principle with arch frames at the mid length, these latter being supported by large columns. The cargo hatches are exceptionally large, consisting of two hatches to each hold, each hatch being 30 feet in length by 25 feet in width. The side coamings of these hatches are continuous and carried about 3 feet above the deck, the covers themselves being of steel in two pieces, divided along the centerline, opening outwards and resting horizontally on the port and starboard rails respectively. These hatch covers are on DeRusset's patented principle, which have been fitted to a large number of American cargo ships as well as to the

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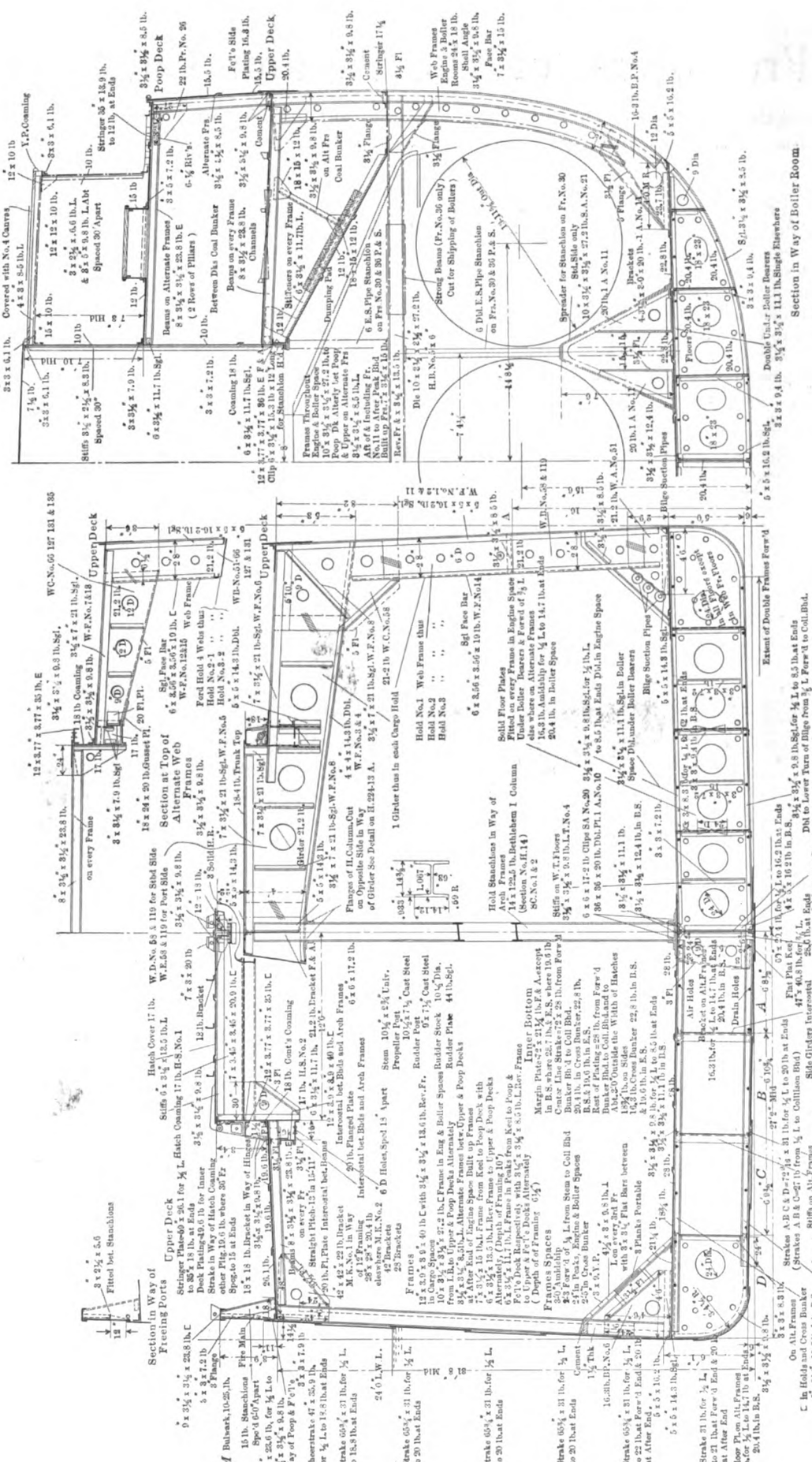

Fig. 3.—Midship Section of the *Atlantic*, Showing Scantlings

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14,000-ton United States naval colliers. In fact, this type of hatch cover would seem to be a greater favorite in America than in the country of its origin.

The cargo discharging appliances consist of nine double drum friction winches made by the Lidgerwood Manufacturing Company, and capable of exerting a pull of 8,000 pounds on a single whip. As these winches are founded on high deck houses at the base of each mast, they enable

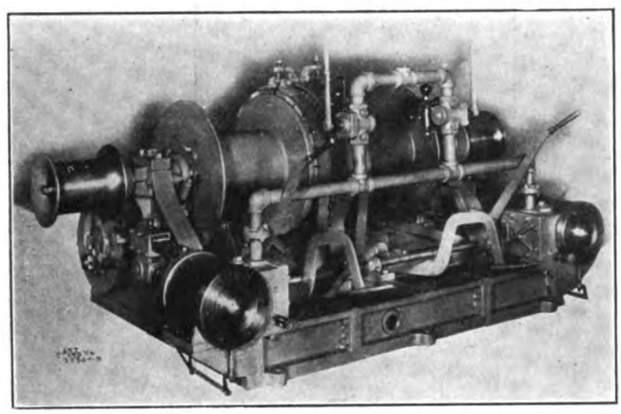

Fig. 4.—Lidgerwood Cargo Winch

a deck load to be carried and properly discharged without interfering with the operator, who, it will be noted, is in quite a commanding position to handle the deck load safely and conveniently. After the deck load has been disposed of, the hatch covers are opened by the cargo falls and rested on the main rail as previously described, enabling the operator to get at the hold cargo and discharge it.

Each winch has two independent friction drums and two winchheads. The levers are all brought to the rear, having the lead for the ropes all clear. There is an independent throttle lever for each side, a hand lever for each friction and a foot lever for each brake. This permits of each drum being operated independently so that with two operators each winch is really two winches, but with the advantage that when an extra heavy load is to be handled the whole power of the engine can be used for the load on one drum. There are two cylinders 8¼-inch diameter and 8-inch stroke. The drums are 14 inches in diameter with 14-inch faces. With both drums loaded the lifting capacity on a single line is 2,500 pounds on each drum, but a 5,000-pound pull can be had on either line, working with only one drum. This type of winch is capable of very rapid cargo handling.

The machinery spaces aft are enclosed by a long loop surmounted by a steel Liverpool house affording accommodations for the engineers, petty officers, and mess rooms with other conveniences, and below deck, port and starboard are berthed the firemen and seamen. The boilers have been arranged three abreast, and the fuel carried in a cross bunker with 'tween deck bunkers in the wing spaces, giving a total capacity of about 850 tons of coal.

Special attention has been given to the water ballast arrangements to provide a much larger amount than is usual in this class of vessel, which has resulted in fitting a 5-foot inner bottom on the bracket and solid floor construction throughout the hold spaces, and a 6-foot inner bottom under the machinery spaces.

It will be noted that the vessel has been rigged with three pole masts, the fore and main masts being of steel and equipped, in combination with two king posts, with thirteen 5-ton derricks and one of 25 tons working capacity, enabling the vessel to be expeditiously loaded and discharged.

The deck auxiliaries consist in addition to the winches already mentioned of a combined steam windlass mounted on the forecastle head, a steel screw and hand steering gear with telemotor control of the Lidgerwood design from pilot house and flying bridge to the engine aft, as well as hand control gear from top of poop deck house. There has also been installed a one-ton Brunswick ice machine, a reversible steam capstan on the poop deck, and an efficient system of steam heat radiators.

The steering engines are of the "screw gear" type. One of them is clearly shown in Fig. 5, together with the telemotor, as they were set up for test in the shops of the Lidgerwood Manufacturing Company. The telemotor is oil filled and is of the standard type with some improvements in details. The steering engine has all spur gearing. The screw for operating the tiller has square threads, highly finished. There is a "trick" wheel for steering by steam at the engine and hand-steering wheels which can be thrown into gear and the steam end disconnected quickly should hand steering become necessary at any time.

One of the little things tending toward safety on Lidgerwood steering engines is that the bolts are all double nutted, the engines have large "save oils," and all the working parts are highly finished and fitted by hand scraping. The connecting rods have the expensive but easily adjusted strap ends with gib and key adjustment and other features peculiar to the Lidgerwood "duplicate part" built engines which have given them their high reputation for durability and efficiency.

The propelling machinery consists of a set of vertical inverted triple expansion engines with cylinders 25 inches, 41 inches and 68 inches in diameter, having a common stroke

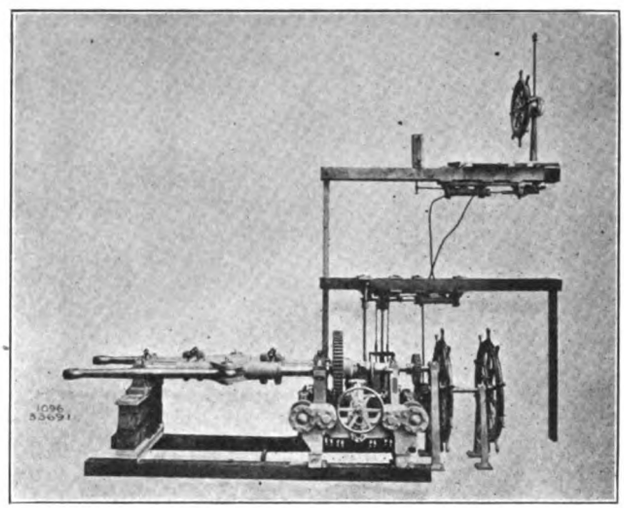

Fig. 5.—Complete Steering Gear Before Installation

of 48 inches and driving a right hand propeller at 75 revolutions per minute. Steam is supplied at 190 pounds working pressure. The cylinders are mounted on hollow cast iron columns of box section, and a separate condenser of wrought steel plate of the cylindrical type is installed. The high-pressure cylinder only is fitted with piston valves and the intermediate- and low-pressure with double ported slide valves.

The valve gear is of the Stephenson link type. The reversing engine is a direct-acting cylinder, operating a forged steel shaft carried in a bearing bolted to the back columns. The turning gear consists of a single cylinder

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engine driving through worm gearing shaft mounted on a sliding cast steel worm.

The propeller is of the built-up type, having a cast iron hub and four removable cast steel blades, the design conforming with Commander Dyson's improved navy type, brass and secured to the bucket by a taper fit with a composition nut pinned on. This pump has 9 inches diameter discharge to the feed tank.

There are two high-pressure feed pumps of the Worthington Admiralty pattern of the vertical duplex type with

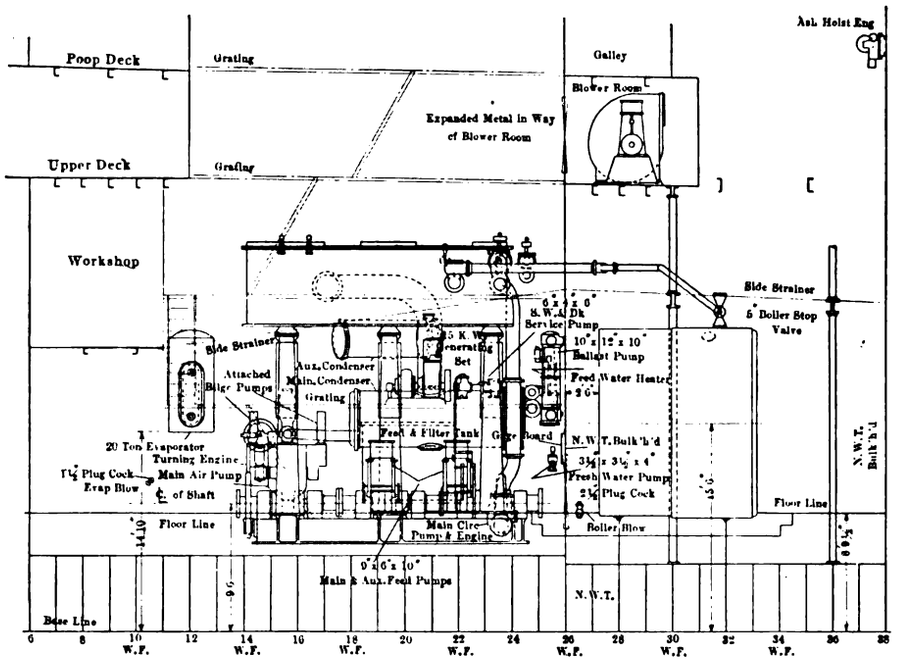

Fig. 6.—Longitudinal Section Through Machinery Space

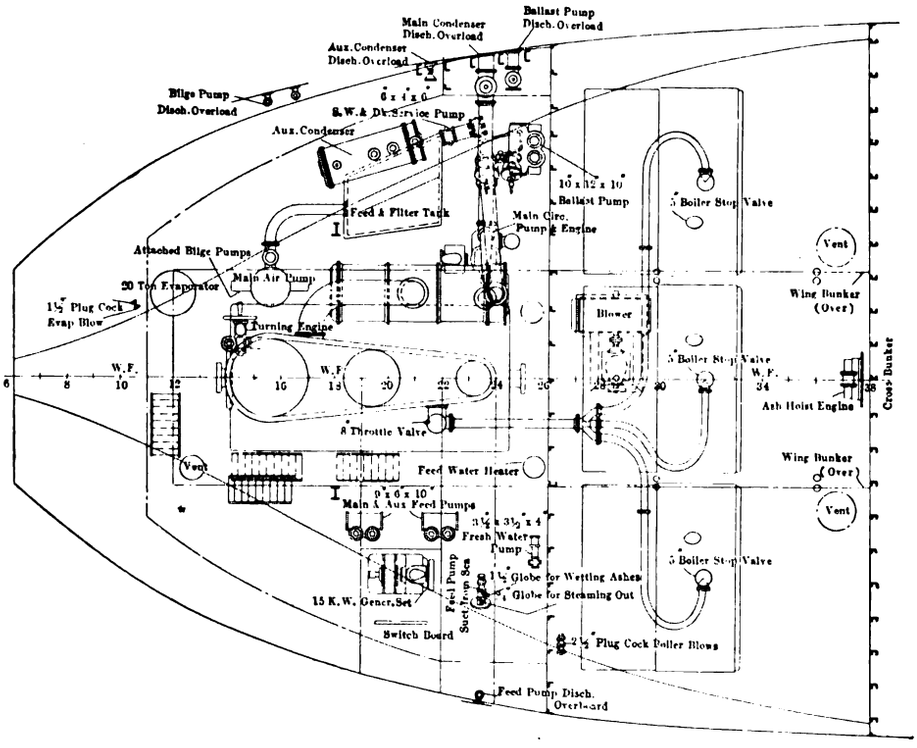
Main Condenser Disch. Overload
Ballast Pump Disch. Overload
Aux. Condenser Disch. Overload
Bilge Pump Disch. Overload
6 x 4 x 6 S.W.& Dk. Service Pump
Aux. Condenser
10" x 12" x 10" Ballast Pump
5 Boiler Stop Valve
Feed & Filter Tank
Main Circ. Pump & Engine
Attached Bilge Pumps
Main Air Pump
20 Ton Evaporator
1½" Plug Cock Evap Blow
Turning Engine
Vent
Wing Bunker (Over)
Blower
5 Boiler Stop Valve
Ash Hoist Engine
Cross Bunker
8" Throttle Valve
Feed Water Heater
9" x 6" x 10" Main & Aux. Feed Pumps
3½" x 3½" x 4" Fresh Water Pump
5 Boiler Stop Valve
1¼" Globe for Wetting Ashes
1" Globe for Steaming Out
15 K.W. Genr. Set
Feed Pump Suct. from Sea
Switch Board
2½" Plug Cock Boiler Blows
Feed Pump Disch. Overboard

Fig. 7.—Plan of Machinery Arrangement

which has proved highly efficient on previous service tests.

The air pump is of the Edwards type bolted to the back column of the engine. This pump is 24 inches in diameter by 20-inch stroke. The bucket and delivery valve seats are of copper with metallic valves and composition valve guards and nuts. The pump rod is of steel covered with composition water ends. These pumps are 9 inches by 6 inches by 10 inches, and are arranged to draw from the sea, reserve feed tank, main air pump, auxiliary condenser, feed tanks and boiler bottoms. There is one ballast pump of the Worthington vertical duplex ballast pump type 10 inches by 12 inches by 10 inches with cast iron water ends.

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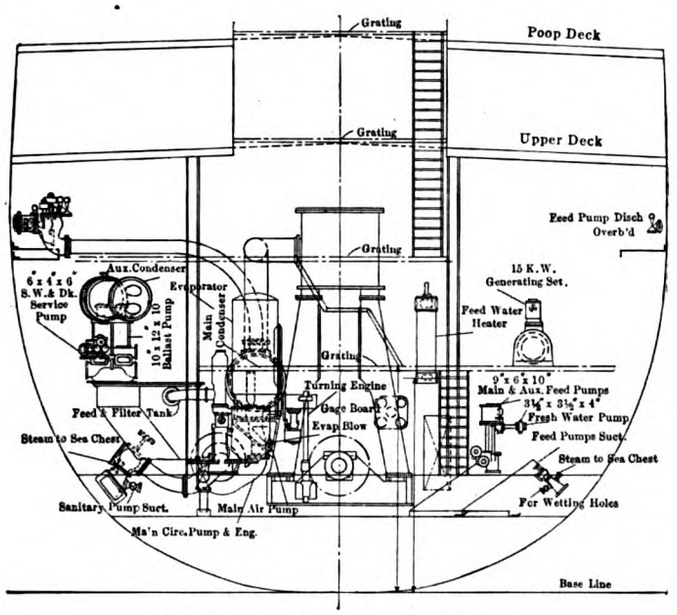


Fig. 8.—Section Through Engine Room

The main boilers are of the Scotch marine type, single ended, and three in number arranged abreast. They are 13 feet 9 inches in diameter by 12 feet long, and have a combined grate area of 155 feet and a total heating surface of 6,500 feet, the ratio being 1 to 42. Each boiler has three corrugated furnaces of the Morison suspension type 42 inches inside diameter. The safety valves are of the

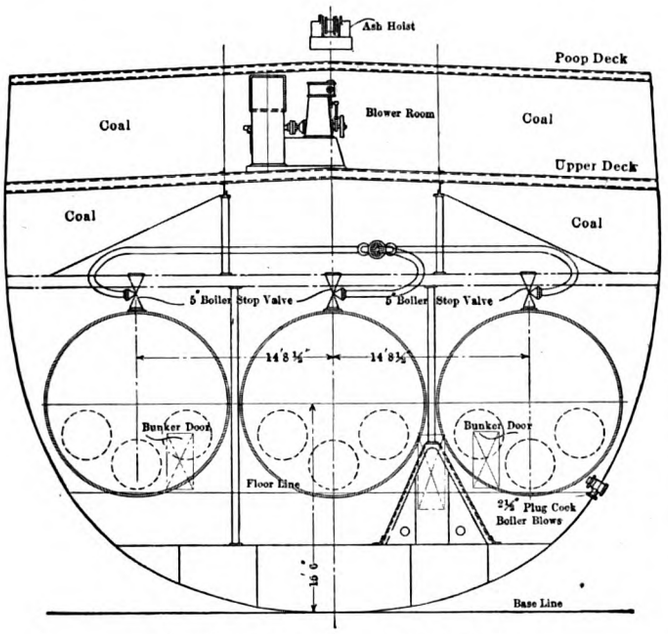


Fig. 9.—Section Through Boiler Room

twin type made by the American Steam Gauge Manufacturing Company. A forced draft installation operated by a Sturtevant fan is provided.

The electric light plant consists of one multiple-phase 6-pole, 15 kilowatt, 115 volt, direct connected General Electric Company marine generating set with a combined generating and distributing switchboard. The distribution is on the two-wire system and supplies current to one 18-inch searchlight and 180 16-candlepower incandescent lamps, as well as the running and signal lights.

The wireless installation is of 2 kilowatt capacity, capable of transmitting messages to a radius of 300 miles, and is supplied from the main generator.

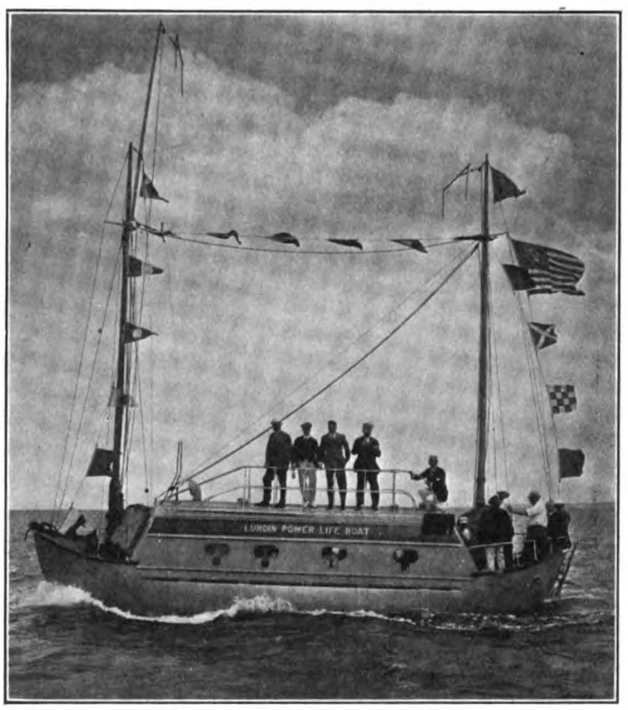
Both hull and machinery have been constructed in conformity with the highest class in Lloyd's Register of Shipping, and the vessel has been supervised during construction by the officers of that society.

It will be found that the *Atlantic* and her sister ship, the *Pacific*, which is about to be launched, are in a class by themselves as far as the bulk carrying and lumber trades in the American coastwise service are concerned. It is doubtful if there are any vessels especially designed for this particular trade approaching them in size, as the *Atlantic*, with a moderate deck load, will carry 5,000,000 board feet of lumber, or alternatively a total bulk deadweight of 9,000 tons, at a speed of 10½ knots at sea on a low consumption of fuel.

Lundin Power Lifeboat Equipped for a Voyage Across the Atlantic

On July 30 a 36-foot Lundin steel power lifeboat, manned by a crew of six, left New York harbor for a voyage to Queenstown and adjacent ports via Halifax and St. Johns, Nova Scotia. With the outbreak of war, however, soon after the boat reached Boston, Mass., the transatlantic voyage was discontinued and the boat returned to New York to wait until hostilities have ceased.

The boat in which this venturesome voyage was begun



36-Foot Lundin Power Lifeboat

is a standard power lifeboat of the type designed by Captain A. P. Lundin, president of the Welin Marine Equipment Company, Long Island City, N. Y. It is 36 feet long, 12 feet wide, with a draft of 27 inches, and weighs 18,900 pounds. The hull is built entirely of galvanized sheet steel and is flatt-bottomed and flat-sided, with fenders of Balsa wood 1 foot thick on each side. Thirty-four inches above the bottom is a steel deck, the space between the bottom and the deck being partitioned off by steel bulkheads into ten air-tight compartments. Access to each

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of these compartments is possible by circular removable covers clamped down on hatches in the steel deck. Automatic scuppers drain through pipes leading down through the bottom of the boat any water that may be shipped.

Amidships the boat is entirely housed in with a steel deckhouse with the ends beveled and fitted with watertight doors, giving access to the cabin. The roof of the cabin is strengthened by eight U-shaped frames of metal in the form of arches, crossing from side to side inside, while outside eight fore-and-aft strips of the same shape of metal are run along the cabin top. Wooden gratings cover the metal floor and eight specially designed ports, four on a side, furnish light for the interior. These swing open to admit air or they may be clamped down watertight, while a separate flap at the bottom of each port may be raised, permitting oars to be used even when the ports themselves are closed. Two masts, 30 feet long, are hinged to fold down on the cabin top in case of bad weather, to permit stowing the boat on the deck of a steamship. Besides the aerial for a wireless outfit, the masts carry two staysails, two trisails and two jibs.

Propulsion of the boat is by a propeller, 27 inches diameter by 39 inches pitch, housed in a tunnel built in the bottom of the hull aft. The motor, which is a four-cylinder, 6 inches by 8 inches, 32 to 37 horsepower Standard gasolene (petrol) engine, manufactured by the Standard Motor Construction Company, Jersey City, N. J., is installed in a covered steel box compartment, 8 feet 3 inches long and 3 feet 6 inches wide, its forward end being 20 feet 7 inches from the stern. The controls for the motor are alongside the helmsman, both the clutch and throttle levers being on one standard. Two 230-gallon seamless steel tanks for gasolene (petrol) are supported on leather-lined steel saddles strapped fast in the bilge compartment on either side of the motor box. A pump on the motor raises this fuel to a small feed tank in the forward port corner of the motor box, where it feeds by gravity to the vaporizer. For the transatlantic trip, extra boxed cans of gasolene (petrol) were stowed in the various air-tight compartments in the double bottom. Fresh water is carried in two cylindrical tanks of 100 gallons capacity each, sunk level with the floor just aft of the engine compartment.

In a silent cabin built of Balsa wood in the forward end of the cabin on the starboard side is installed a complete Marconi wireless outfit, capable of transmitting messages 100 miles and receiving messages from 600 to 1,000 miles. The wireless outfit is identical with that installed in the United States submarines. Electricity is generated in a 110-volt direct current dynamo belted to the flywheel of the motor. The electrical equipment also includes a complete Dayton electric light outfit with a 3½ kilowatt, 110 volt dynamo supplying current for lighting the boat, for cooking, and also for a 7-inch Carlisle & Finch searchlight.

Ventilation is provided by air vents in the top of the house, so designed that they will automatically close if turned upside down. One of these, fitted with a cowl, is over the wireless room, two are over the main cabin, one of which feeds air through a pipe down into the forward end of the engine compartment. A blower belted to a pulley on the shaft at the after end draws air out and up through a vent over the after end of the engine box. Two vents are installed in the after end of the cabin.

The crew for the transatlantic voyage consisted of Mr. E. Sivard, superintendent of the Welin Marine Equipment Company, and his bride; Captain B. A. Rigoulot, navigator; Charles Klentberg, assistant navigator; Walter Petersen, engineer, and H. J. Meldrum, wireless operator. All of the crew were experienced men and little difficulty was anticipated in making the long voyage in such a small boat, for repeated tests under a great variety of conditions have shown that the boat is thoroughly seaworthy and reliable for the roughest kind of work. The boat has been approved and passed by the United States Steamboat Inspection Service and rated for a capacity of 100 persons.

Aero Automatic Fire Alarm

A fire-alarm system that will detect and announce a fire, together with its location, within a few seconds after the fire has started, and that is adjustable to operate under any conditions, and also discriminate as adjusted between a gradual and a sudden rise of temperature, is being manufactured and installed by the Aero Automatic Fire Alarm Company, 6 Church street, New York.

This system, simple in theory and decidedly practical and effective in operation, is exactly contrary to the action of any thermostat system, which is necessarily sensitive to local heats and takes no cognizance of how widespread a heat may be. "Aero" might, therefore, be termed "the

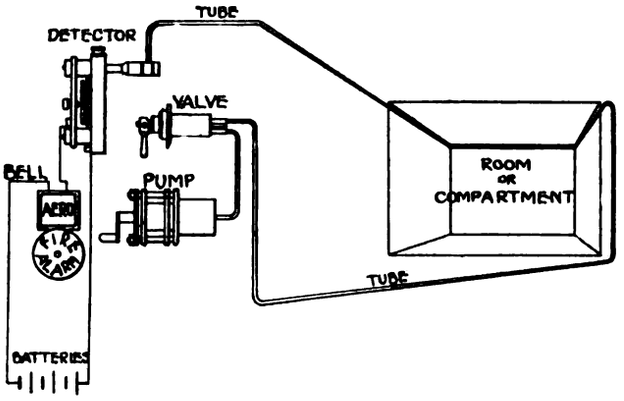

Fig. 1.—Diagrammatic Sketch of Aero Fire Alarm System

universal thermostat." It consists essentially of a fine capillary tube, filled with air at atmospheric pressure, connected to a delicate pressure recorder in the form of a diaphragm and, in series with these, a compensating device in the form of an adjustable vent or leak. The center of the pressure recorder diaphragm forms one point of contact in an electric circuit which is closed by a very minute expansion of the diaphragm. The vital part of any fire alarm consists of its operation up to this point, that of closing the circuit, after which the system's accomplishments are unlimited.

The tube, which is copper, is of very small bore, so that it will present a very large ratio of heating surface to air contained. It is almost impossible to render the tube inoperative, since it is only necessary to have a very small opening through any section of the tube where it might become bent or twisted so long as the section is not made air tight. The whole system may be tested with absolute certainty by means of a pump arrangement creating a slight increase of pressure throughout the tube. If there is no leak in the system, and if there is communication throughout, a slight pressure caused by the pump will operate the alarm, and in this manner the whole system may be tested in a few seconds at the alarm station.

The compensating device or vent is in the form of a porous washer held in place and adjusted by a screw. Tightening the screw decreases the size of the pores in the washer, and therefore renders the whole system more sensitive. In other words, the washer, as set for given conditions, allows air in the tube to escape at a certain

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rate when the pressure of that air attempts to rise above that of the atmosphere. A rise in temperature will cause the air in the tube to expand at a certain rate dependent on the rate of rise of the temperature and independent of the initial temperature. Therefore, if the rate of rise of temperature will cause a rate of rise of pressure in the tube that is greater than the rate of escape of the air in the vent, then the alarm will be sounded by the diaphragm expanding to complete the electrical circuit. This a complete system of tubing, vent, detector, etc. On board the *Washington Irving,* of the Hudson River Day Line, New York, where a complete Aero automatic fire alarm system was installed, the ship is divided into sections forward and aft on each deck and in the hold. Each section has its line of tubing, leading to the main annunciator with a separate detector for each section, so that when the alarm sounds the board lights up showing the deck and location on that deck with respect to amidships of the

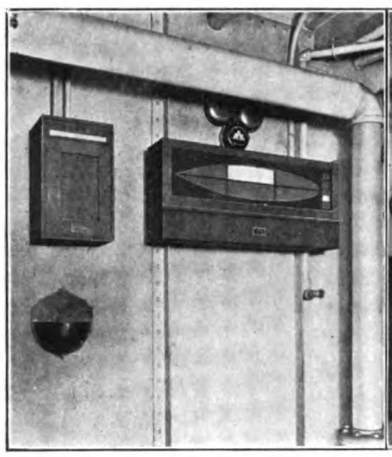

Fig. 2.—Sub-Station in Engine Room

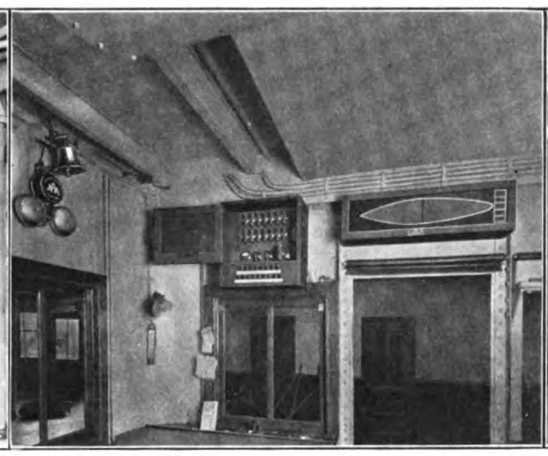

Fig. 3.—Main Switchboard on Deck, Open, Showing Detectors, Testing Air-Pump, Valves and Circuit Signals

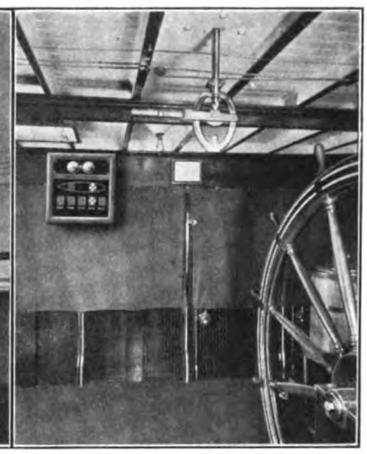

Fig. 4.—Auxiliary Annunciator in Pilot House

naturally furnishes an ideal system for fire alarm on board ship, since it is adaptable to all conditions of temperature and will take care of refrigerating room and boiler room equally well.

The applications of the "Aero" system here shown give an idea of its unlimited use and adaptability, not only in marine service, but under any conditions where an alarm should be installed, as, for instance, on a steamship pier or in a warehouse.

The system as installed comprises a number, each unit fire. As the *Washington Irving* is a day boat, its decks are most all wholly open, and therefore it is not necessary to further divide the system, since a fire can easily be seen if its general location is known.

On the *See and Bee,* of the Cleveland & Buffalo Transit Company, Cleveland, Ohio, which is not only the largest passenger vessel on the Great Lakes, but also the largest side-wheel steamer in the world, a complete system of the Aero automatic fire alarm has also been installed. On this vessel it became necessary to subdivide the boat to a

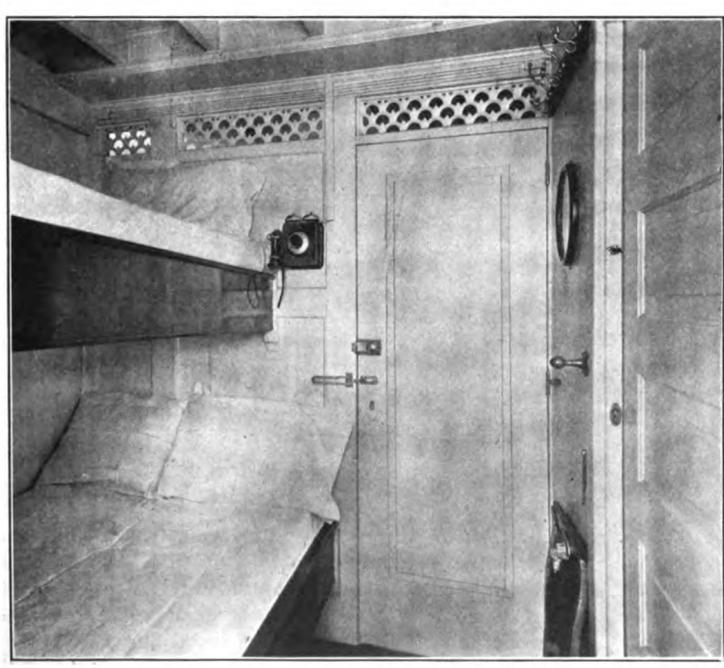

Fig. 5.—Stateroom, Showing Tubing Looped Over Ventilators

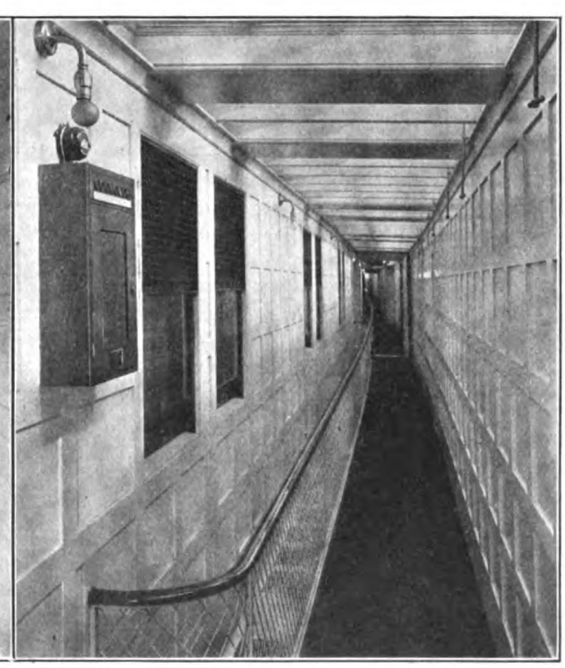

Fig. 6.—Sub-Station on the *See and Bee*

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greater extent than was done on the *Washington Irving*.

This was done by means of sub-stations which show the exact location of the fire, while the main stations in the engine room and pilot house show the general location, so that the engineer and captain are better prepared to give definite orders for fighting the fire. The main annunciators in the engine room and pilot house show immediately what deck the fire is on and whether forward or aft of amidships. The sub-stations, which are also in the form of annunciators, announce the exact location of the fire, so that those on duty at that station can immediately respond to orders without making the alarm general. In this way a fire may break out and be controlled without sounding a general alarm and without unnecessarily exciting the passengers on the ship.

Producer Gas Towboats

Low cost of operation is the main reason for using gas-producers in connection with marine or gasoline (petrol) engines. According to figures supplied by manufacturers of this type of machinery, units even smaller than 50 horsepower can develop one brake-horsepower on one pound of coal, while in an ordinary steam plant of the same horsepower from four to eight times as much coal per horsepower-hour is required. Furthermore, as in a producer-gas plant eight pounds of coal will do the work of a gallon of gasoline (petrol), it will be found that producer-gas coal at $5 (1/0/10) per ton will prove as cheap as gasoline (petrol) or other oil at two cents (1d.) a gallon. The cost of operating a producer-gas plant, therefore, is equivalent to buying coal for a small boiler plant as low as $1.25 (5/2½) a ton. Suitable fuel for marine gas producers can be bought in small quantities in New York at $4 (16/8) per ton, and in larger quanities at still lower figures.

In addition to its remarkable economy, the marine gas-producer weighs but from one-fourth to one-third as much as a Scotch marine boiler, and takes up only about one-third as much space as a watertube boiler. It also requires less help, as the coal is charged into the producer in large quantities in comparatively cool quarters at intervals of about four hours, whereas with a steam plant it is necessary to have stokers in constant attendance.

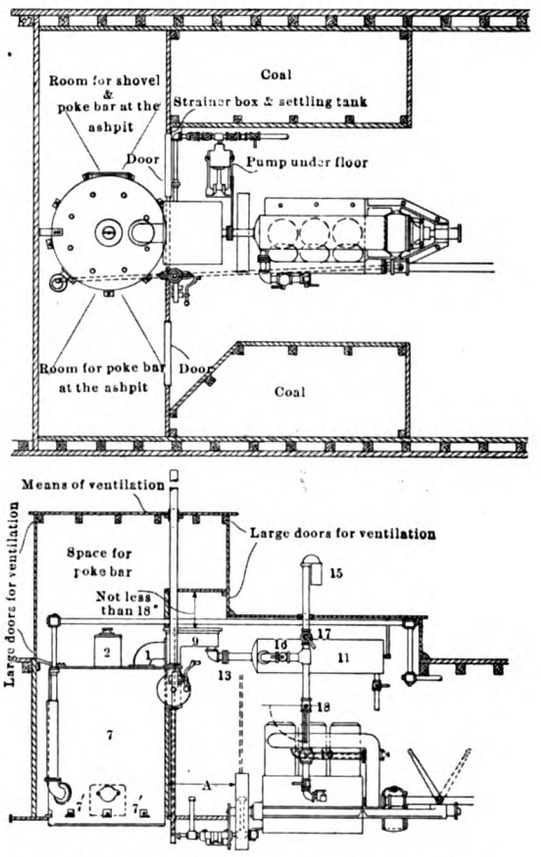

Fig. 2.—Typical Marine Gas-Producer Installation

In Fig. 2, which is a sketch of a typical marine gas-producer installation, 7 is the generator. This is simply a cylindrical shell resting on end and held down by means of the lugs 7′. In the bottom of this shell is an ash pit, above which is a shaking grate. The inside vertical walls are lined with brick. The smaller cylinder, 2, on top of the generator is the coal hopper, by means of which the generator is charged with coal or other solid fuel. The gas generated leaves by the pipe elbow, 1, on top, and goes to the scrubber, 9. As the gas is at this time hot and dusty, it is treated with water in the scrubber, where it is cooled, washed and dried. The gas is then ready for use, and goes through pipe, 13, to chamber, 11, and then through valve 16, and down to the engine. Air is drawn in through pipe, 15, the amount being controlled by the amount of opening to valve 17. The gas and air are then mixed, making an explosive mixture in pipe *T* below 17; 18 is the throttle valve and 19 the intake manifold of the engine.

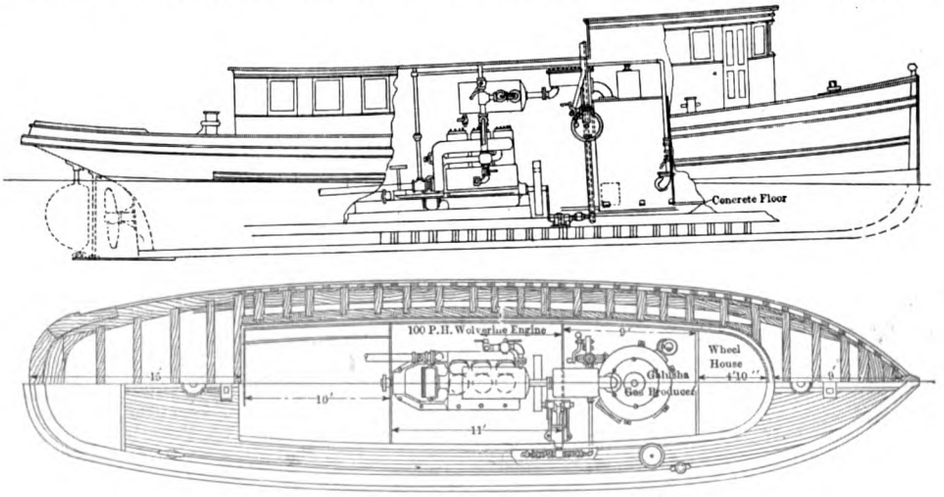

Fig. 1.—General Arrangement of Towboat *Webb*

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Fig. 1 shows the general arrangement of the towboat *Webb*, 63 feet long over all, 14 feet 4 inches beam and 7 feet depth, equipped with a 100-horsepower marine gas-producer and engine. The coal consumption of this plant is only 100 pounds per hour. It is the third producer-gas towboat placed in operation by one concern within eighteen months.

Wolverine IV is a steel towboat 50 feet long by 11 feet 3 inches beam, and 5 feet 3 inches draft, owned by the American Fruit & S. S. Company, of New Orleans, La. This boat has been in active operation since 1910. The power equipment consists of a 75-horsepower engine and producer. According to the owners, the power plant works with the utmost regularity and with minimum attention. The boat is used on long hauls of several days' duration with the engine running full power practically all the time. The consumption of anthracite coal, about ⅜ inch to ½ inch in size, including the stand-over consumption at night, varies from 600 to 704 pounds per twenty-four hours when the boat is in operation ten to twelve hours per day. The engine can be run dead slow or at any intermediate speeds up to about 300 revolutions per minute without any tendency to stop or without disengaging the clutch. As a consequence of the satisfactory results obtained with *Wolverine IV*, the American Fruit & S. S. Company have added half a dozen producer-gas propelled boats to their fleet during the past year.

What is probably the smallest producer-gas towboat is the shallow-draft tunnel stern boat *Wolverine I*. The boat is 32 feet long and has a draft of about 18 inches. The gas-producer and engine are of 18 horsepower.

Another shallow-draft, semi-tunnel stern boat, although of a somewhat larger size, is the *Teddy*. The boat

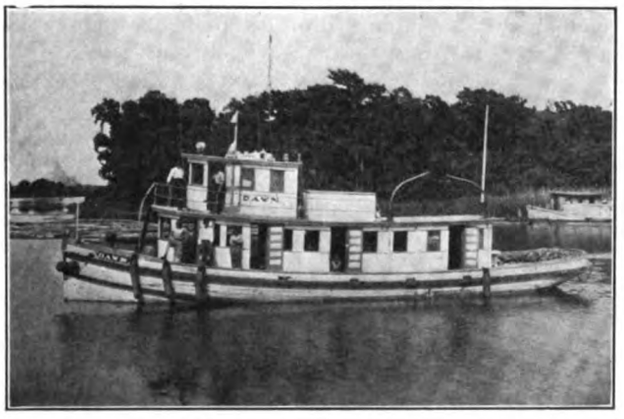

Fig. 3.—Towboat *Dawn* Fitted with 100-Horsepower Wolverine-Galusha Power Plant

is in use night and day and covers a course of 226 miles each way. The 40-horsepower gas-producer installed is in charge of Mexicans, half Indian, and in operation consumes 39 pounds of charcoal per hour. This fuel is said to give almost no ash and to produce an excellent grade of gas for the engine.

The towboat *Dawn*, shown in Fig. 3, which is owned by Locke, Moore & Co., Ltd., is 64 feet long, 14 feet beam and 6 feet deep, equipped with a 100-horsepower gas-producer plant. The boat is engaged in towing logs down the Calcasieu River, a distance of about thirty-five miles. Forty hours are required to make the trip, bringing down an average load of 2,000 logs. According to the owners, the consumption of coal is 100 pounds per hour, or 4,000 pounds for the trip, costing $16.50 (3/8/9), or 44¼ cents (1/10⅛) per hour. If the engine is run on gasoline (petrol) instead of producer-gas, it burns twenty gallons of gasoline (petrol) per hour, or 800 gallons on the same trip, costing $96 (20/0/0) for the trip, or $2.40 (10/0) an hour. Boats of the same power engaged in the same work, equipped with a steam plant burning wood as fuel, cost about 75 cents (3/1½) an hour for fuel, in spite of the fact that wood is the cheapest fuel to be had in that locality. In other words, the steam-tug fuel bill is 80 percent greater than that of the producer-gas tug. In addition to this, the steam tugs are obliged to have an

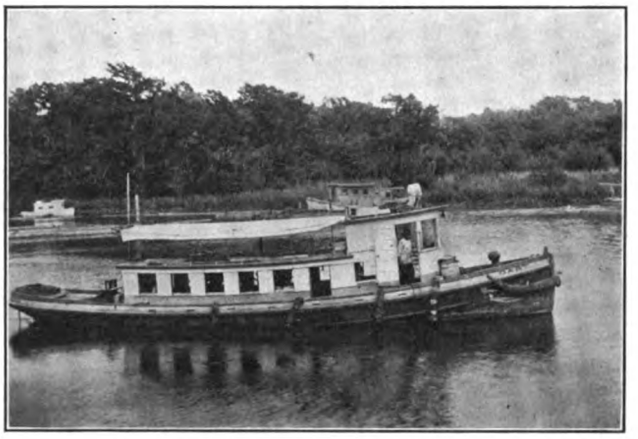

Fig. 4.—Towboat *Dart*, Fitted with 50-Horsepower Wolverine-Galusha Power Plant

additional man on board as fireman, costing $2 (8/4) per day.

Another producer-gas towboat, named the *Dart*, a view of which is shown in Fig. 4, has been engaged in general towing for a couple of years. Its owners report that the boat operates on approximately 50 pounds of coal per hour. If operated on gasoline (petrol) instead of coal it consumes approximately 15 gallons of gasoline (petrol) per hour. As coal costs the owners $8.25 (1/14/4½) per ton, and gasoline (petrol) 12 cents (0/6) per gallon, it will be seen that the comparative fuel costs per hour are 20½ cents (0/10¼) for producer-gas, as against $1.80 (7/6) for gasoline (petrol).

A striking illustration of the difference in fuel cost was made by towing a single barge, light, with this boat a distance of 90 miles, using gasoline (petrol) as fuel and making the same trip again under identical conditions, but using producer-gas as fuel. With gasoline (petrol) it took twenty hours to make the trip and 300 gallons of gasoline (petrol) were burned, which, at 15 cents (0/7½) per gallon, made the total fuel cost $45 (9/7/6). On producer-gas it required twenty-one hours to make the trip, and 1,050 pounds of coal were burned, which, at $8.25 (1/14/4½) a ton, made the total fuel cost $4.33 (18/0), a difference in favor of the gas-producer as compared with gasoline (petrol) of $40.70 (8/9/7) in a twenty-hour run.

The gas-producers installed on the boats mentioned above were built by A. L. Galusha & Co., Boston, Mass., while the engines were of the Wolverine make, manufactured by the Wolverine Motor Works, Bridgeport, Conn.

MONTHLY SHIPBUILDING RETURNS.—The Bureau of Navigation, Department of Commerce, reports 120 sailing, steam and unrigged vessels of 17,849 gross tons built in the United States and officially numbered during the month of July. Four steel steamships, aggregating 6,377 gross tons, were built on the Atlantic coast and 6 steel steamships, aggregating 2,082 gross tons, were built on the Great Lakes.

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New Mallory Line Freight Ships

Two Single-Screw Freight Steamers of 6,600 Tons Deadweight Capacity and 14 Knots Speed Built at Newport News

Two new freight ships, the *Neches* and *Medina*, of 6,600 tons dead-weight capacity each, have just been completed by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Mallory Steamship Company, New York. The *Neches* has just completed her six-hour endurance trial, and reached New York August 21 on her maiden trip. The *Medina* will undergo trials this month.

The new ships were designed by Theodore E. Ferris, naval architect and marine engineer, New York, from lines laid down by H. H. Raymond, vice-president and general manager of the Mallory Steamship Company. With a cubic capacity of 350,000 cubic feet, a dead-weight cargo capacity of 6,600 tons and a designed speed of 14 knots, they are among the most modern and largest freight steamships operating on the Atlantic coast. A most complete equipment for rapid loading and discharging cargo has been provided, consisting of nine cargo ports with clear openings of about 8 feet by 6 feet on each side of the 'tween decks, a large over-all hatch forward and four additional cargo hatches, the largest of which is 24 feet by 15 feet, together with six double-drum, quick-acting hoisting winches, ten 8-ton cargo booms and one 30-ton cargo derrick with a compound, double-drive winch.

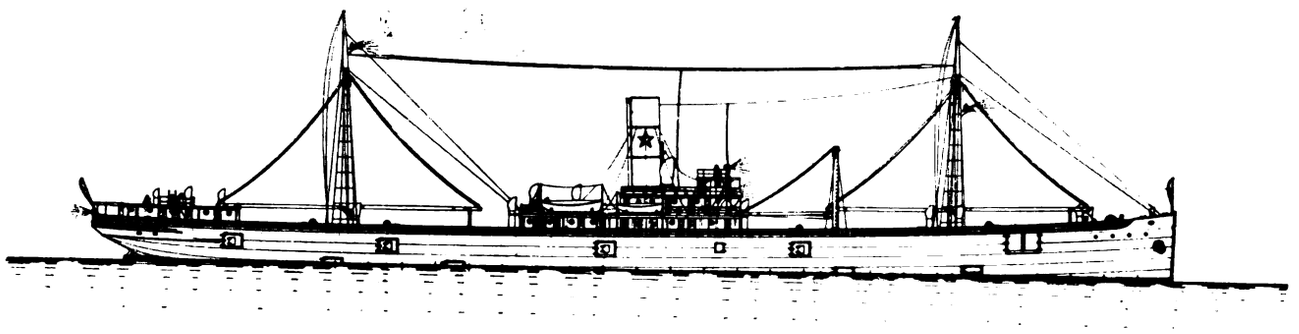

Fig. 1.—Outboard Profile of the *Neches*

The *Neches* and *Medina* are of the hurricane-deck type, having a complete steel hurricane deck, main deck and lower deck. They are 421 feet long on deck, 405 feet long between perpendiculars, 54 feet 3 inches beam, 35 feet 9 inches molded depth to the hurricane deck, with a load draft of 24 feet. There are five transverse watertight bulkheads forming three cargo holds and 'tween-deck cargo spaces. The cargo holds and 'tween decks

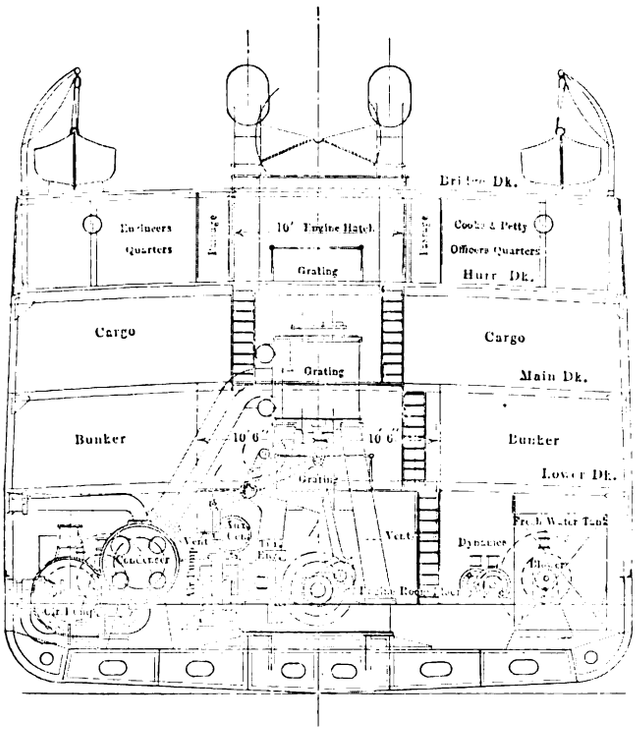

Fig. 2.—Section Through Engine Room

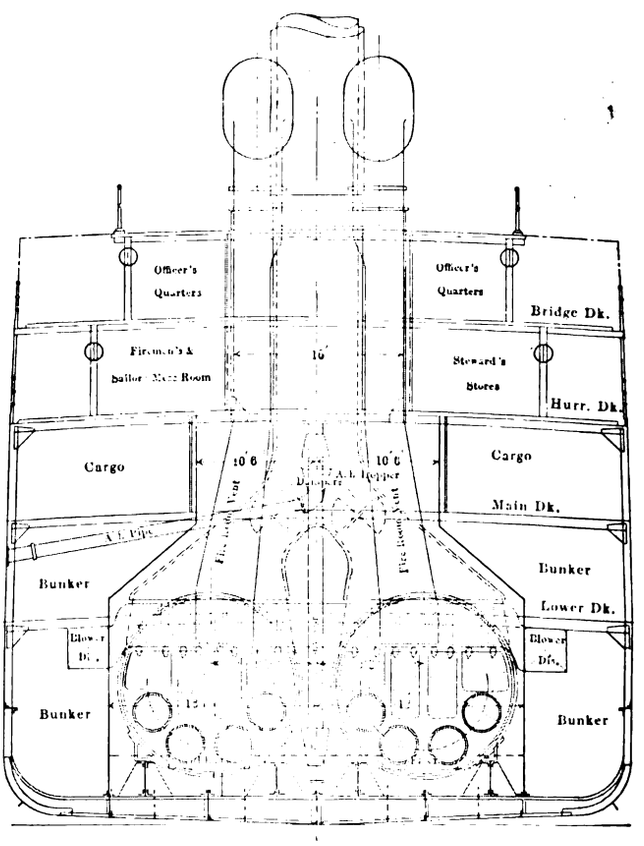

Fig. 3.—Section Through Boiler Room

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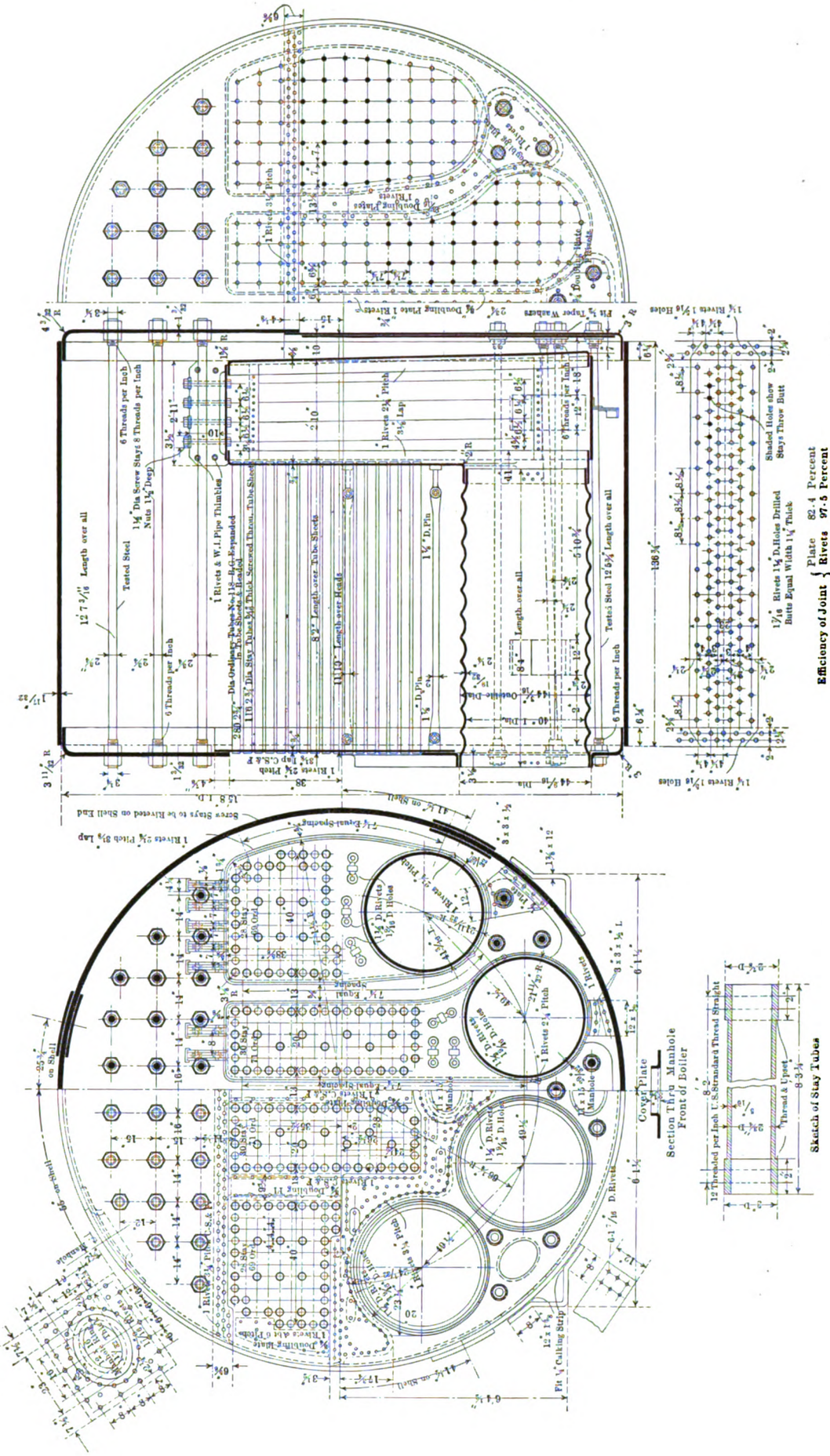
Efficiency of Joint { Plate 82.4 Percent
Rivets 97.5 Percent
Butts 105.7 Percent
Section Thru Manhole Front of Boiler
Sketch of Stay Tubes

Fig. 4.—Detail Plans of Boilers for the *Neches* and *Medina*

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are amply ventilated for the transportation of perishable cargo by large ventilators and cowls at the weather decks, and, in addition, the upper 'tween decks are mechanically ventilated by air ducts and electrically operated fans. Two direct-connected motors and fans in the engine-room casing discharge into one common duct led into the smoke-stack. This system of mechanical ventilation is provided for transporting onion cargoes and other similar commodities and further to provide against excessive temperature. The hurricane deck, in addition to being a complete steel deck, is sheathed with wood-calked decks for insulating purposes.

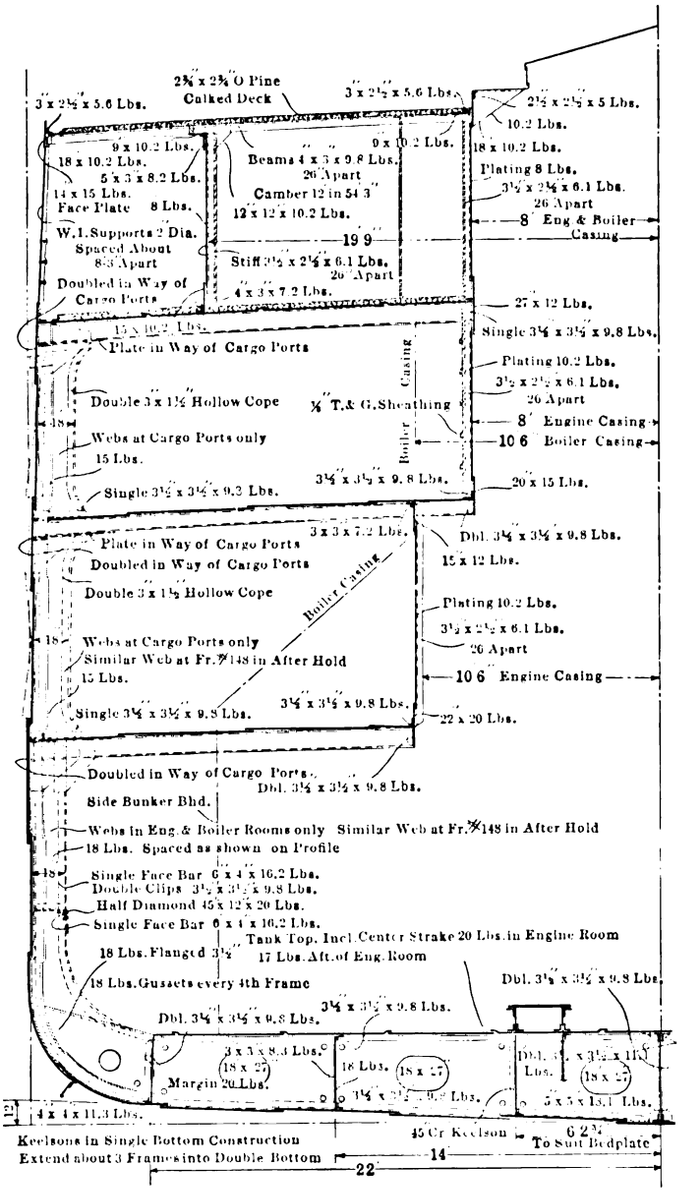
2¾" x 2¾" O Pine Calked Deck
3" x 2½" x 5.6 Lbs.
3" x 2½" x 5.6 Lbs.
2½" x 2½" x 5 Lbs.
10.2 Lbs.
9" x 10.2 Lbs.
18" x 10.2 Lbs.
5" x 3" x 8.2 Lbs.
14" x 15 Lbs.
Face Plate 8 Lbs.
W.L. Supports 2" Dia. Spaced About 8'-3" Apart
Doubled in Way of Cargo Ports
Beams 4" x 3" x 9.8 Lbs. 26" Apart
Camber 12 in 54'-3"
12" x 12" x 10.2 Lbs.
19'-9"
Stiff 3½" x 2½" x 6.1 Lbs. 26" Apart
4" x 3" x 7.2 Lbs.
Plating 8 Lbs.
3½" x 2½" x 6.1 Lbs. 26" Apart
8' Eng & Boiler Casing
27" x 12 Lbs.
Single 3¼" x 3½" x 9.8 Lbs.
15" x 10.2 Lbs.
Plate in Way of Cargo Ports
Boiler Casing
Plating 10.2 Lbs.
3½" x 2½" x 6.1 Lbs. 26" Apart
Double 3" x 1½" Hollow Cope
¼" T. & G. Sheathing
8' Engine Casing
10'-6" Boiler Casing
Webs at Cargo Ports only 15 Lbs.
3¼" x 3½" x 9.8 Lbs.
20" x 15 Lbs.
Single 3½" x 3½" x 9.3 Lbs.
Plate in Way of Cargo Ports
3" x 3" x 7.2 Lbs.
Dbl. 3¼" x 3¼" x 9.8 Lbs.
15" x 12 Lbs.
Doubled in Way of Cargo Ports
Double 3" x 1½" Hollow Cope
Boiler Casing
Plating 10.2 Lbs.
3½" x 2½" x 6.1 Lbs. 26" Apart
Webs at Cargo Ports only
Similar Web at Fr. ⅋148 in After Hold 15 Lbs.
10'-6" Engine Casing
3¼" x 3½" x 9.8 Lbs.
Single 3¼" x 3½" x 9.8 Lbs.
22" x 20 Lbs.
Doubled in Way of Cargo Ports
Dbl. 3¼" x 3½" x 9.8 Lbs.
Side Bunker Bhd.
Webs in Eng. & Boiler Rooms only Similar Web at Fr. ⅋148 in After Hold
18 Lbs. Spaced as shown on Profile
Single Face Bar 6" x 4" x 16.2 Lbs.
Double Clips 3½" x 3½" x 9.8 Lbs.
Half Diamond 45" x 12" x 20 Lbs.
Single Face Bar 6" x 4" x 16.2 Lbs.
Tank Top, Incl. Center Strake 20 Lbs. in Engine Room
18 Lbs. Flanged 3½"
17 Lbs. Aft. of Eng. Room
18 Lbs. Gussets every 4th Frame
Dbl. 3¼" x 3½" x 9.8 Lbs.
3¼" x 3½" x 9.8 Lbs.
Dbl. 3¼" x 3½" x 9.8 Lbs.
3" x 3" x 8.4 Lbs.
(18" x 27")
Margin 20 Lbs.
18 Lbs.
(18" x 27")
Dbl. 3¼" x 3½" x 11.5 Lbs.
(18" x 27")
3¼" x 3½" x 9.8 Lbs.
5" x 3" x 13.1 Lbs.
4" x 4" x 11.3 Lbs.
45 Cr Keelson
6 2¾
To Suit Bedplate
Keelsons in Single Bottom Construction
Extend about 3 Frames into Double Bottom
14
22

Fig. 5.—Section in Way of Engine Room

ACCOMMODATIONS

Amidships, on the hurricane deck, steel deck-houses are erected providing space for cold-storage rooms, galley, pantry and separate messrooms for the officers, firemen and sailors, a steward's storeroom, quarters for the engineers, steward, cooks, messmen, carpenter, boatswain, watchmen, oilers', petty officers' and engineers' washrooms. In a steel deck-house above are provided rooms for the capatin, the first, second and third officers, quartermasters, pursers and wireless operators. Above this house are the wheel-house and navigating bridge. Aft, on the hurricane deck, is a steel house for the firemen's and sailors' quarters, and also space for the steering engine, above which is a docking bridge.

HULL CONSTRUCTION

The hull has a straight stem and elliptical stern, two steel masts and two derrick hoists. In way of the machinery space and 26 feet aft of the engine room, a double bottom is fitted in which the feed-water is carried. The double bottom is built on the cellular system, with floors on every frame and two intercostal keelsons of 18-pound plate on each side. It is divided into two compartments on each side of the vessel with a drainage well across at the end of the engine room. The center vertical keel is continuous between peaks and intercostal for a distance of three frame spaces in the peak. Outside the double bottom the vertical keel is fitted with a rider plate. The two keelsons on each side of the center keel consist of continuous double angles on top of the floors, with intercostal plates. Side stringers consisting of a continuous angle and an intercostal plate are fitted in the hold. These are increased to the width of the web frames in the machinery space.

The frames, spaced 26 inches apart throughout, are 6-inch by 3½-inch by 13.5-pound angles in the peaks, extending from the center line to the hurricane deck and cut at the water-tight flats. For about three-fifths the length amidships, depending on the shape of the lines, the frames are 3½-inch by 3½-inch by 9.8-pound angles, with 7-inch by 3.45-inch by 3.45-inch by 20.9-pound channels around the bilge, and extending to the hurricane deck on every frame. Beyond three-fifths of the length amidships to the peak bulkheads the channels will extend down to the side line at the keel. In the double bottom the frames are 3½-inch by 3½-inch by 9.8-pound angles; 3½-inch by 3½-inch by 9.8-pound angle reverse frames are fitted in the forepeak, extending to the hurricane deck on every frame. Similar reverse frames, extending to the main and hurricane decks alternately, are fitted in the after peak. Reverse frames of the same size are fitted across the top of the floors in way of channel frames. These are double in the boiler room and also in the double bottom under the main engine only, elsewhere they are single. The floors are 30 inches by 20 pounds for half length amidships, reduced to 15 pounds at the ends. In the boiler room the floors are 30 inches by 23 pounds, and in the double bottom 45 inches by 18 pounds.

Deck beams are fitted on alternate frames in both the lower and hurricane decks, while on the main deck beams are fitted on every frame, the scantlings of which are shown on the midship section.

The side plating of scantlings shown in the midship section are worked in in-and-out strakes with overlap butts throughout. Doubling plates are fitted at all cargo ports.

Five water-tight bulkheads extend to the main deck, while non-water-tight bulkheads are fitted between the main and hurricane decks fore and aft of the machinery space and in the lower 'tween decks between the engine and boiler rooms. The lower half of the bulkheads to the lower deck are of 14-pound plate, and the upper half between the lower and main decks of 12-pound plate. Between the main and hurricane decks the bulkheads are of 10.2-pound plate. Vertical stiffeners consisting of 6-inch by 3½-inch by 3½-inch by 15.2-pound channels bracketed both top and bottom and spaced 30 inches apart, are fitted below the lower deck. Between the lower and main decks, 5-inch by 3-inch by 9.8-pound angle stiffeners are fitted,

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while between the main and hurricane decks the stiffeners are reduced to 3½-inch by 3½-inch by 6.6-pound angles. Special stiffening is introduced on the peak bulkheads.

An ash bunker is built of plates, and angles on the main deck over the forward battery of boilers, and contains the ash-hoisting engine and gear. Fresh water is carried in

The boiler shells are 1 17/32 inch thick, the upper heads 1 3/32 inch thick, and the tube sheets ¾ inch thick. The tubes, of which there are 396 to each boiler, are 2¾ inches outside diameter and 8 feet ½ inch long between tube sheets. The furnaces are 40 inches diameter, with grates 5 feet 6 inches long.

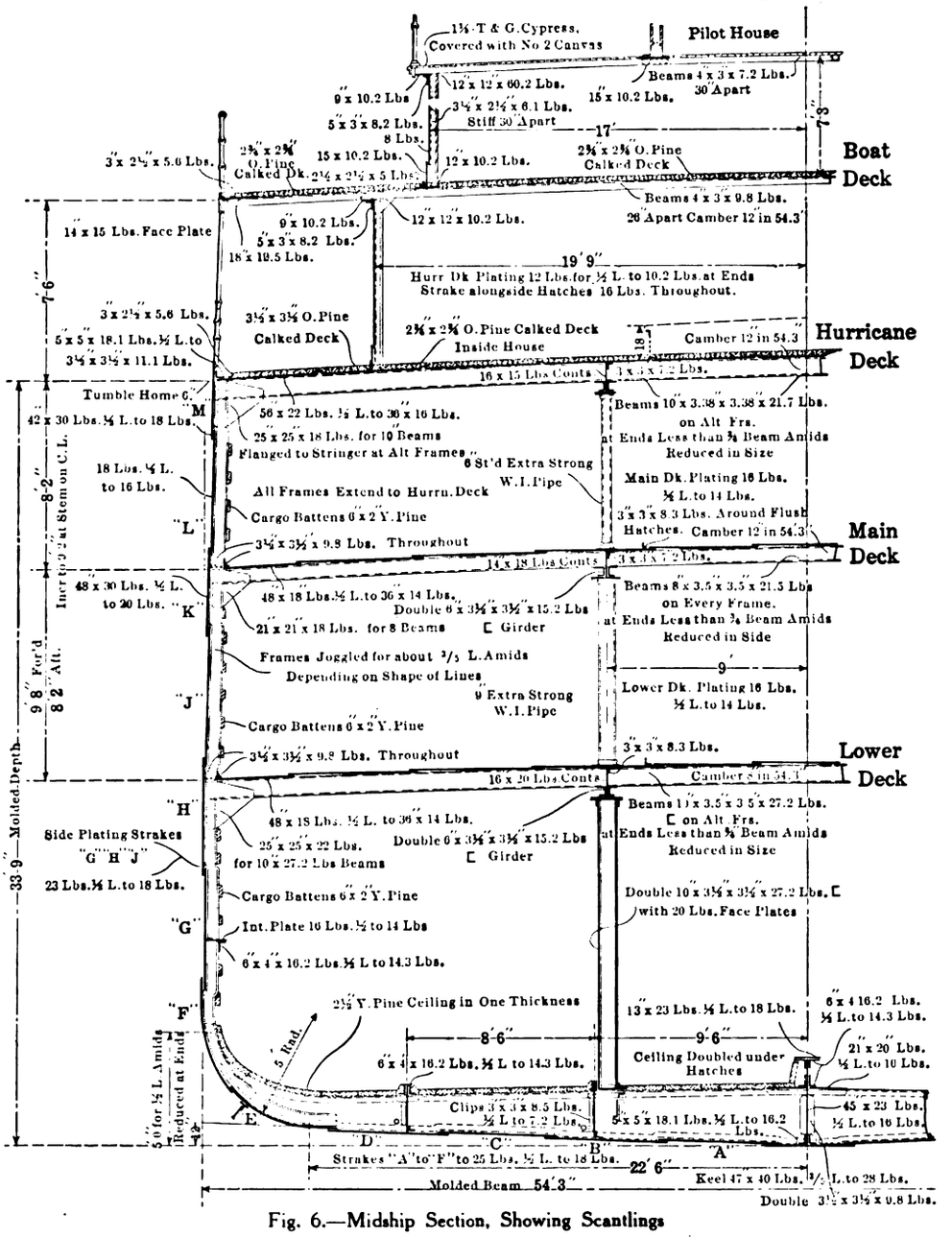

Fig. 6.—Midship Section, Showing Scantlings

two tanks with a total capacity of 30 tons, located on the starboard side of the main engine room.

BOILERS

Steam is supplied at 200 pounds per square inch working pressure by four four-furnace Scotch boilers, 15 feet 8 inches inside diameter and 12 feet long over heads, fitted with heated forced draft. Each boiler has 2,843 square feet of heating surface distributed as follows: Tubes, 2,293 square feet; furnace, 222 square feet; combustion chambers, 328 square feet. The grate area of each boiler is 73.5 square feet, making a ratio of heating surface to grate area of 38.8 to 1. The boilers are designed to evaporate 235 pounds of water per square foot of grate area, or 17,270 pounds per hour per boiler.

The forced-draft equipment consists of two Sturtevant multi-vane fans located in the engine room, driven by vertical 6-inch by 5-inch blower engines. The fan-wheels are 3 feet 4¾ inches diameter, and are designed to maintain a combustion of 25 pounds of coal per square foot of grate, creating a pressure of at least 1½ inches of water at the boiler furnaces. The air is drawn from the fire rooms.

The ash-handling gear consists of an endless-chain conveyor with a sheet-iron casing, dumping the ashes into a hopper on the main deck.

MAIN ENGINES

Propulsion is by a single screw of the solid type, 17 feet 3 inches diameter and 19 feet 9 inches pitch, made of

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manganese bronze, actuated by a triple-expansion engine of 4,100 indicated horsepower, with cylinders 29 inches, 49 inches and 84 inches diameter, with a common stroke of 54 inches operating at 85 revolutions per minute. The high and intermediate-pressure valves are of the piston type, while the low-pressure cylinder is fitted with a double-ported slide valve. The valve gear is of the Stephenson double-bar link type. The main air and two bilge pumps are worked off the main engine.

The crank and thrust shafts are 16½ inches diameter, the line shaft 15⅜ inches diameter, and the tail shaft 17¼ inches diameter and 19 inches over the sleeve. Water service taken from the sea is provided for the main bearings, crank-pins and thrust and steady bearings. Cooling water for circulating through the guides and for spraying the crosshead-pins is taken from the sanitary service, the water being retuned to the sanitary service.

Auxiliaries

The main condenser is independent, of circular section, with cast-iron shell and a cooling surface of 6,800 square feet. The auxiliary condenser is of similar type, with 800 square feet of cooling surface. The main air pump is of the Edwards type, 30 inches by 24 inches, attached to the main engine. The auxiliary air pump is of the horizontal combined Blake type 10 inches by 12 inches by 12 inches by 12 inches. The main circulating pump, which has a 42-inch diameter runner and 17-inch pipe, is driven by a 9-inch by 10-inch engine. The auxiliary circulating pump is a horizontal combined Blake pump, 10 inches by 12 inches by 12 inches by 12 inches. Two bilge pumps, 7 inches and 5½ inches diameter by 24-inch stroke, of the plunger type, are attached to the main engine.

The other auxiliary pumps, located in the engine room, include a vertical duplex Blake main feed pump, 12 inches by 8½ inches by 12 inches, and a duplicate auxiliary feed pump; a vertical duplex Blake fire and bilge pump, 12 inches by 8½ inches by 12 inches; a vertical simplex Blake sanitary pump, 6 inches by 12 inches by 6 inches and a vertical simplex Blake fresh-water pump, 4½ inches by 6 inches by 6 inches. The main feed pump draws from a feed-water filter tank of 1,400 gallons capacity in the engine room and the fresh-water manifold and discharges either through the feed-water heater or direct to the boilers.

An electric plant is provided consisting of two 10-kilowatt turbo-generators supplied by the Terry Steam Turbine Company. The feed-water heater is of the Reilly Admiralty type, and there is also a 2-ton capacity Brunswick direct-expansion ice machine for cooling the steward's cold-storage boxes, which have a cubic capacity of 783 cubic feet.

Deck Auxiliaries

The ships are equipped with a Hyde steam windlass and steam capstans of the Hyde make, the windlass being

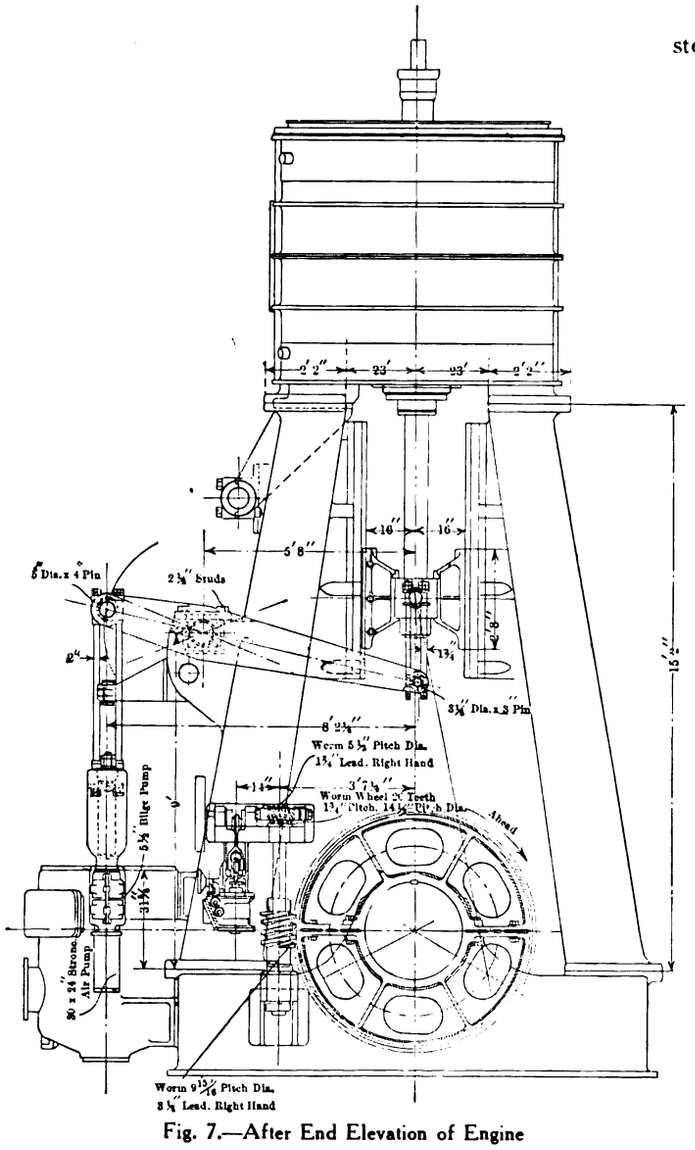

Fig. 7.—After End Elevation of Engine

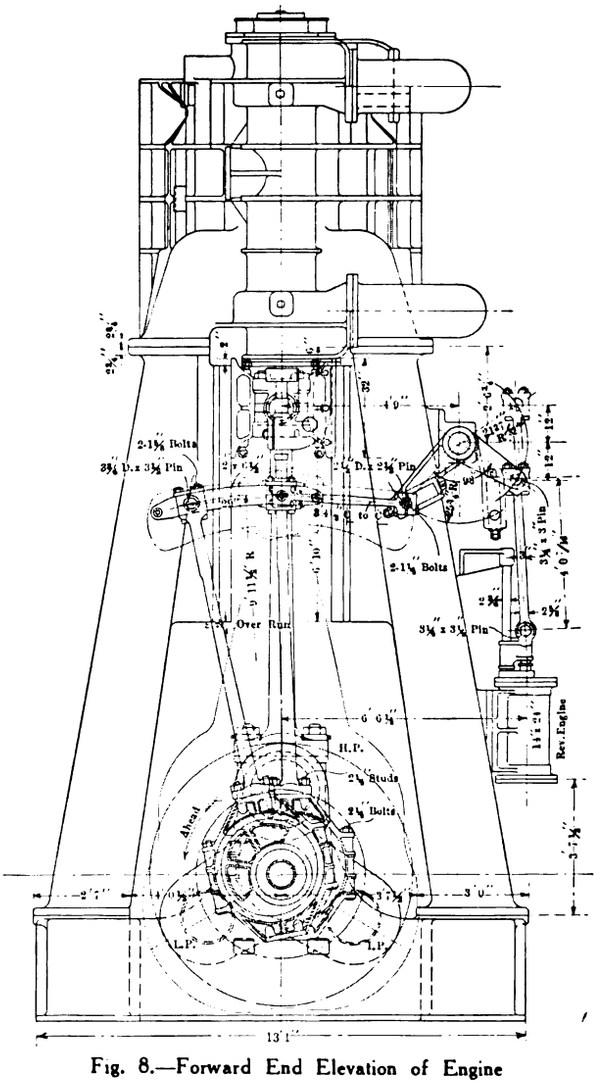

Fig. 8.—Forward End Elevation of Engine

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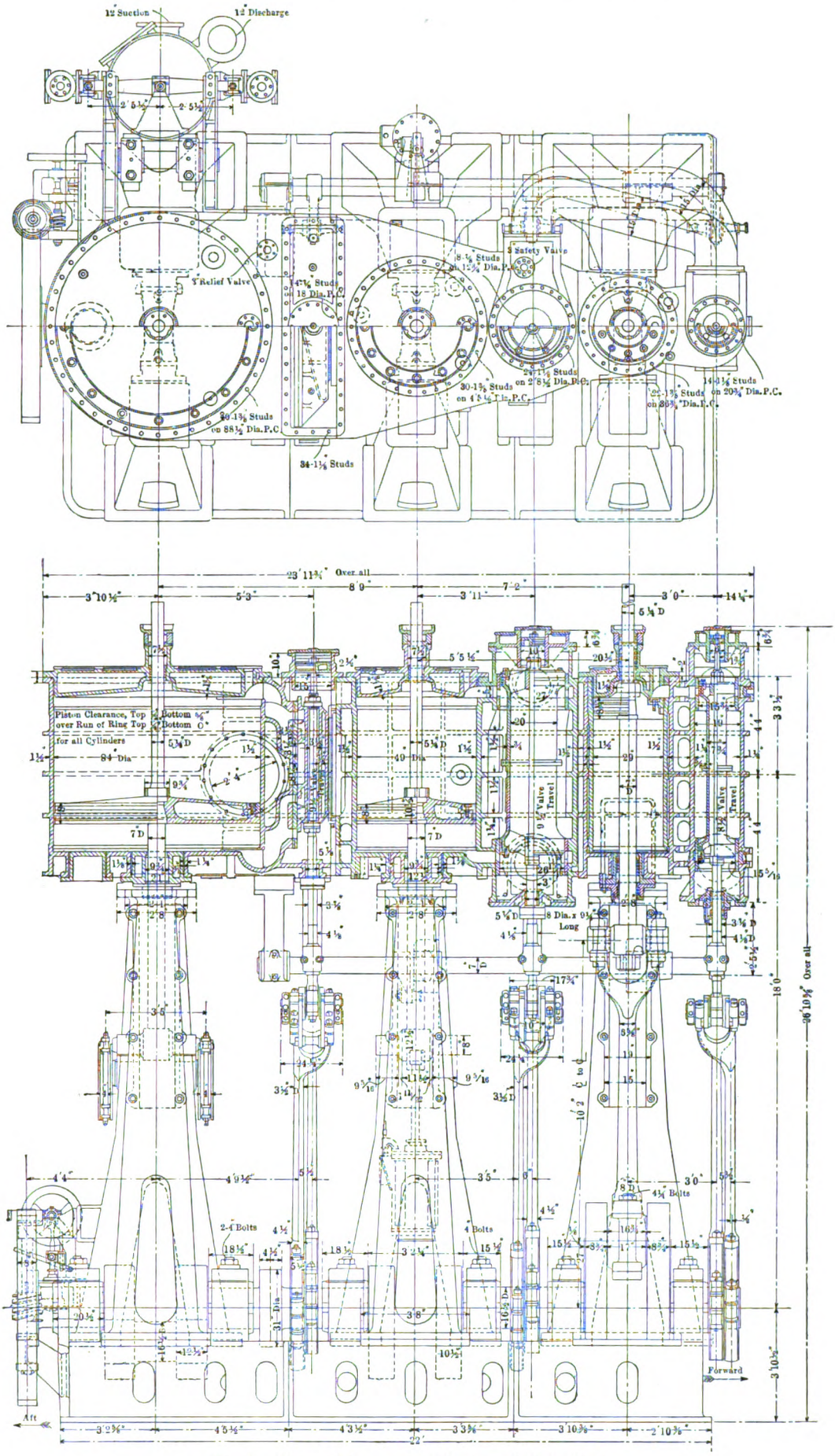

Fig. 9.—Plan and Longitudinal Section of Main Engine

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driven by a 12-inch by 12-inch engine and the capstans by 8-inch by 8-inch engines. The equipment of winches for handling freight is very complete, there being six double-drum, quick-acting hoisting winches, all of the Williamson make. Four winches, with cylinders 8 inches by 8 inches, are for the 8-ton cargo booms, and two with cylinders 7 inches by 7 inches for the 3-ton booms. For the 30-ton derrick there is one compound type, double-drum Williamson winch, with cylinders 10 inches by 12 inches.

Both hand and steam steering gear of the Williamson make are fitted, the steam gear being operated by telemotor control from the wheel house. The steam steering engine, which is direct connected at the rudder stock with right- and left-hand screw, is 9 inches by 9 inches.

In addition to the complete electric lighting and steam-heating equipment, the vessels are fitted with wireless apparatus, submarine bells, electric fog whistles and complete navigating outfits.

Bolinder's Direct Reversible Marine Oil Engine

The construction details and method of operation, showing simplicity, reliability and accuracy of workmanship, together with the performance of the engine in actual installation, show why the Bolinder's engine has influenced the modern movement toward hot-bulb, or semi-Diesel, engines and inspired their wide adoption.

The Bolinder's engine is built by the Bolinder's Company, at Stockholm, Sweden, and by the Bolinder's Company, New York, 30 Church street, New York City. In

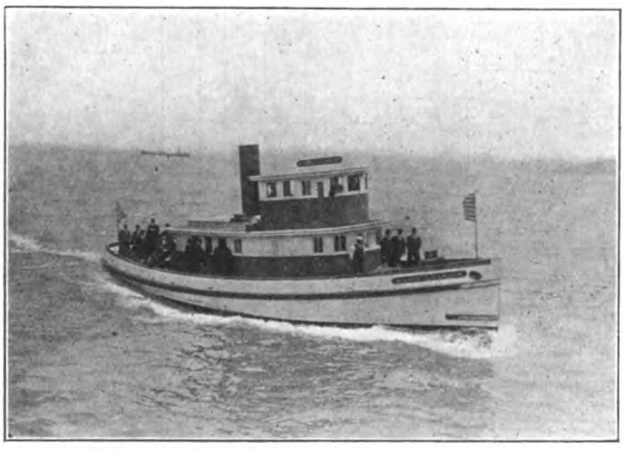

Fig. 1.—Towboat *Marie L. Hanlon*, Fitted with 160-Horsepower Bolinder Engine

producing these engines there are parts which are finished to half a hundredth of a millimeter (1/5,000th of an inch). This remarkable standard of accuracy is required for fuel-pump barrels and rams, while in the other details of the engine the accuracy is of the order associated with Diesel motor construction, and grinding is extensively used. All this wonderful accuracy does not improve the heat efficiency or mechanical efficiency to any appreciable extent, but in conjunction with the selected materials it gives to the engines a durability that ensures the maintenance of the initial efficiency at a minimum running expense. An outline of the cycle of operations will, however, show the possibilities of heat efficiency and economy of operation.

The Bolinder's crude-oil engine is of the modern two-cycle type, delivering a power impulse for each revolution of the crank. It has no valves, cams, gears or electric-sparking device and the construction is such that all parts work automatically and cannot be thrown out of adjustment. On the upstroke of the piston *A*, Fig. 2, a partial vacuum is created in the enclosed crank case *C*, causing the necessary charge of air to rush in at the two opposite inlets *B*. Near the end of the upstroke an oil pump automatically injects the proper amount of oil through the nozzle *F* into the ignitor ball *E*. The latter has been previously heated to a dull red heat by a blow-lamp, so that the hot walls of the same immediately convert the oil into a vapor which mixes with the air compressed in the cylinder and ignites. This creates pressure, driving the piston downward, and during the down-stroke the air, previously drawn into the crank-case, is compressed.

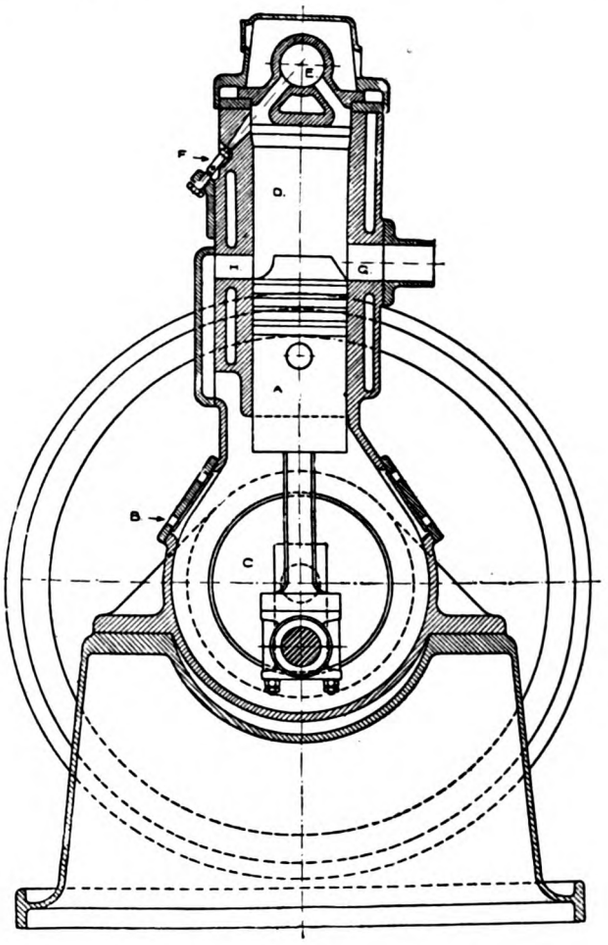

Fig. 2.—Section of Bolinder Engine

When the piston approaches the end of the down-stroke it uncovers the exhaust port *G*, permitting the burnt gases to escape through the port to the silencer, so that the pressure approaches that of the atmosphere. Immediately after port *G* is opened the transfer port *H*, on the opposite side of the cylinder, is uncovered by the piston, allowing the charge of compressed air in the crank-case to rush into the cylinder, where it is deflected upward by the baffle-plate shape of the top of the piston, thereby scavenging the cylinder of exhaust gases and filling it with air close to atmospheric pressure, which is again compressed on the upstroke of the piston. Due to the two ports of the ignitor ball *E*, the ball is thoroughly cleaned of all deposit by means of the fresh air rushing through it. This is a decided advantage, ensuring powerful ignition and doing away with excessive carbon deposit.

The cycle of operations such as outlined is common to

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all two-cycle types of engines, and while the Bolinder engine embodies many distinctive features of simplicity and reliability, it is chiefly due to the fuel feeding and reversing mechanism that attention has to be drawn, for these have contributed greatly to its commercial and engineering success. For each cylinder there is a separate main fuel pump, which in single-cylinder engines is mounted on the after end of the engine, a similar position being occupied by the brace of main fuel pumps for a double-cylinder set, while in a four-cylinder motor the main fuel pumps are fitted in pairs at the forward and after ends of the engine. An auxiliary fuel pump for reversing is combined with each main fuel pump group. The principal parts of the fuel-pump mechanism are: A crescent-shaped rocker bearing at each end a point to strike the rams of the fuel pumps, one horizontal and one vertical; a "T"-shaped pump casting, between which and the crescent-shaped rocker is a bell crank with faced ends. This gear is mounted directly to a bracket supported on the after end of the cylinder jacket in such a manner that the whole can be swung through a small arc in a vertical plane. The crescent rocker receives motion from an eccentric rod driven by the crank-shaft, and provides for the actuation of whichever fuel pump may be in service.

When the motor is running in the direction for ahead propulsion the bell crank that selects the appropriate fuel pump rests with its horizontal arm upon a stop while the downward or vertical arm lies with its faced end so far to the right that the adjoining point on the end of the crescent rocker is moved off the line of the vertical fuel pump. It is the horizontal fuel pump that feeds the injections to the motor, subject to governing. To reverse the direction of running, a handle at the side of the engine is drawn astern, which has the effect of moving in a transverse direction the rod that is pinned to the bell crank, and at the lower end of which is a rhomboidal link surrounding a friction disk on the shaft. If the rotation be for ahead the link will be resting with its "right-hand" side against the friction disk, the motion, therefore, tending to keep it down so that the horizontal arm of the bell crank is held down on the stop, as already mentioned. On drawing the reversing lever astern, the link is pulled over until its "left-hand" side is against the friction disk, causing a lifting effect on the rod and tilting the bell crank upwards so that the horizontal pump is thrown out and the vertical one thrown in. This allows the crescent rocker to give the vertical fuel pump an impulse on the compression stroke, delivering the oil into the hot bulb during that stroke and causing combustion to occur before the piston reaches the upper dead center. This reverses the direction of rotation and the friction which gave the bell crank an upward motion or lift will have its direction reversed with the opposite rotation and cause a downward motion to the bell crank, throwing out the vertical and throwing in the horizontal pump. Thus it is seen that the auxiliary pump is used only for reversing, and that reversing may be done either way by the same or analogous method.

Fig. 1 illustrates the *Marie L. Hanlon*, a tow-boat, which lately went into commission on San Francisco Bay, and is fitted with a two-cycle, two-cylinder Bolinder engine of 160 brake horsepower, at 225 revolutions per minute. The hull of this vessel is 71 feet 9 inches long by 17 feet 9 inches beam by 8 feet 6 inches draft. The engine was tried on California oil before it was installed in the vessel, and it was found that the machinery functioned satisfactorily on crude oil provided the oil was well filtered and heated to about 100 degrees before injection. The engine was found to operate perfectly on "Diesel engine" oil, a residue product of the asphalt refineries, without any preheating or extra filtering of any kind. On a trial trip the engine was run on a governor at a rate which developed 125 horsepower. No attempt was made to force the vessel, but the average of several runs over the measured mile course gave an average speed of 11.28 miles per hour. While no attempt was made on this trip to obtain accurate data on fuel consumption, it is estimated at about 140 gallons, at 2.4 cents per gallon, for a day of ten hours.

The Talbot Marine Watertube Boiler

An oil-fired watertube boiler of exceptionally small size and weight per horsepower, for which remarkably high thermal efficiency is claimed, has been placed on the market by the Talbot Boiler Company of New York. The weight of a 100-horsepower boiler of this type, including all accessories, is only 5,000 pounds, or 50 pounds per horsepower, while the floor space occupied is only 3½ feet by 5 feet and the height 6½ feet. Automatic controlling devices regulate the supply of feed-water to the boiler and of oil to the burners, making the boiler immediately responsive to the demands for steam.

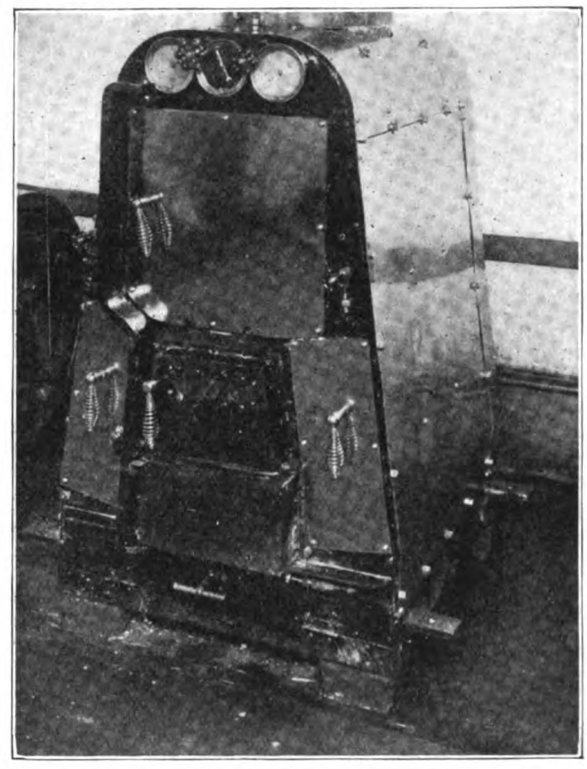

Fig. 1.—Talbot Watertube Boiler

The water enters the upper part of the boiler and the steam is discharged from the lower part, where the heating surface is directly in contact with the highest furnace temperatures. With the water and gases of combustion circulating in opposite directions two important advantages are obtained; first, the uptake gases are delivered at a much lower temperature than that of the steam generated, thus enabling the boiler to be operated at a high rate of thermal efficiency, and second, the rapid circulation of water tends to eliminate the formation of scale in the tubes and keeps the tubes clean.

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CONSTRUCTION

The boiler consists of a number of specially cored, crucible steel headers arranged horizontally one above the other into each of which are screwed several groups of single-ended tubes also arranged horizontally. The free ends of the tubes are welded and flattened to permit the use of a wrench in removing or installing them. Inside the tubes, as shown in Fig. 2, are smaller circulating tubes leading into separate cored spaces or chambers in the header. The peculiar coring of the headers causes the water which enters at one end of the header to pass through the group of inner or circulating tubes leading from the first core or chamber and return through the outer tubes to the next core or chamber, which in turn connects the outer tubes of the first group with inner tubes of the next group of circulating tubes and so on. As the water passes successively through the groups of tubes in each header, beginning at the top and finally issuing at the bottom as steam in order to prevent the water from gravitating at once to the lower part of the boiler. Each header is conneced to the next header below it by a trap.

Two somewhat smaller headers are arranged obliquely at the sides of the furnace, while at the back of the furnace is a crucible steel wall so cored that the steam from the top of one of the side headers is carried through this wall to the bottom of the other side header, which is the last header in the series of circulation. This coring is so proportioned that a high velocity is maintained throughout during the operation of the boiler.

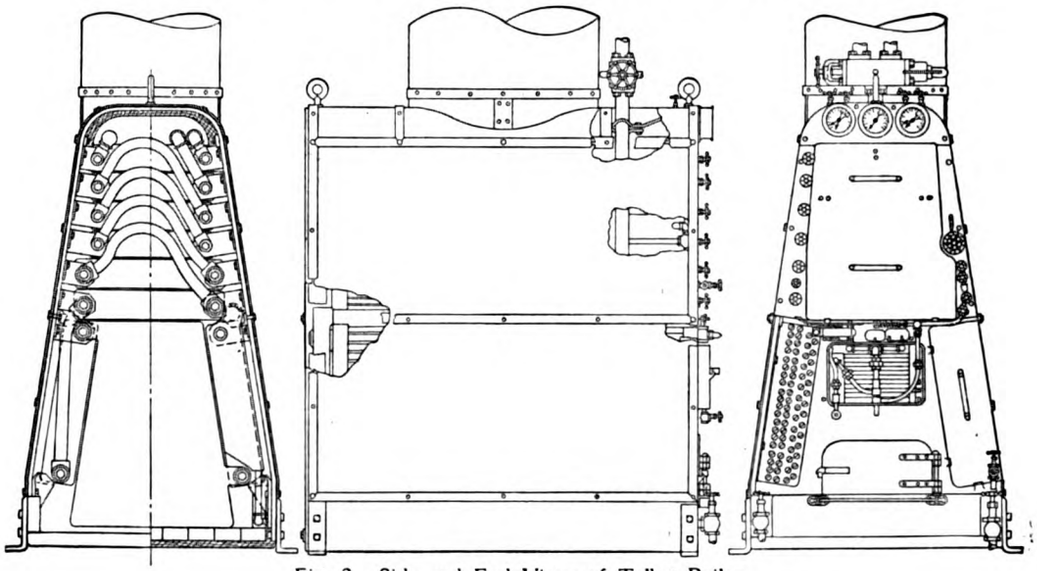

Fig. 2.—Side and End Views of Talbot Boiler

The tubes and headers are supported on a framework consisting of four vertical stanchions. A jacket is secured to the outside of the stanchions or framework and the space between the tubes and these panels is insulated with asbestos-magnesia. At the opposite end of the boiler from the header end are tube-supporting plates and a door frame which protects the tube sheets from the intense heat of the furnace. The tube sheets are secured to the framework in the same manner as the headers.

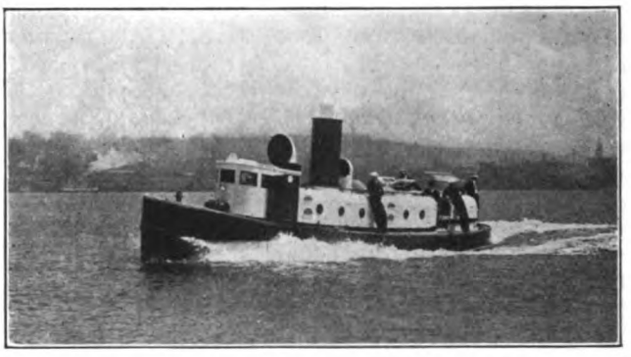

Fig. 4.—Naval Tender Fitted with Talbot Boiler

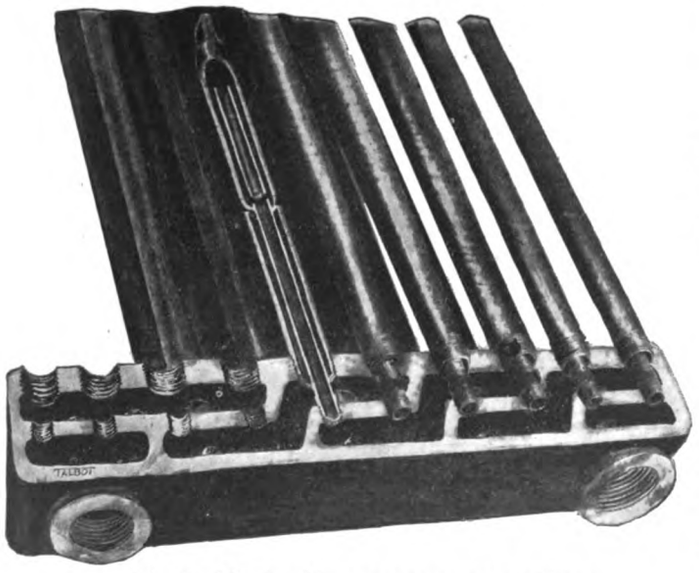

Fig. 3.—Header, Showing Arrangement of Tubes

FEED REGULATOR

On the door frame at the front of the boiler, through which the feed water first circulates, is an automatic feed regulating device of the piston type operated by compound levers connected to one of the nearby tubes in the last group of the circulating series. The position of this regulating tube is such that it is subject to the greatest heat not only of the furnace, but from the steam within the tube. As the tube becomes hotter and expands, the valve connected to it is actuated by the connecting levers, so that it admits water to the boiler, which in turn cools and contracts it, reducing the supply of water to the boiler.

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It is claimed that when steam enters, this valve adjusts itself automatically and remains with a certain opening under ordinary working conditions. After the feed has passed through the door frame and through this valve, it is delivered to the upper header at the top of the boiler through a hand regulated valve designed to adjust the superheat within certain limits and to steady the action of the automatic regulating device.

An automatic safety device operated by the regulating tube is also provided which cuts off the oil to the burner when the heating surface of the boiler becomes overheated. The simple nature of the regulating devices on this boiler and the use of oil fuel make the boiler very easy to handle, while the savings in weight and space, and the economy of fuel consumption, make the boiler particularly suited for marine work.

In a conspicuous place at the top of the boiler are gages showing the oil pressure, the feed-line pressure and the steam pressure, and also a temperature gage connected to the regulator tube which shows the water conditions in the boiler.

Lengthening the Steam Yacht Cyprus

The steam yacht *Cyprus*, described in the December, 1913, issue of INTERNATIONAL MARINE ENGINEERING, has recently been lengthened 35 feet at the yards of the Seattle Construction and Dry Dock Company, Seattle, Wash., for Mr. D. C. Jackling, of Salt Lake City. The vessel was altered from specifications by the original designers, Messrs. Cox & Stevens, New York, and under their supervision. The work consisted of adding about 35 feet between the engine and boiler rooms, lengthening both and forming additional fuel oil tanks, quarters to accommodate twelve of the crew and three assistant engineers and four large staterooms for guests. A raised forecastle was also added, giving the boat a decidedly better profile and more crew accommodation.

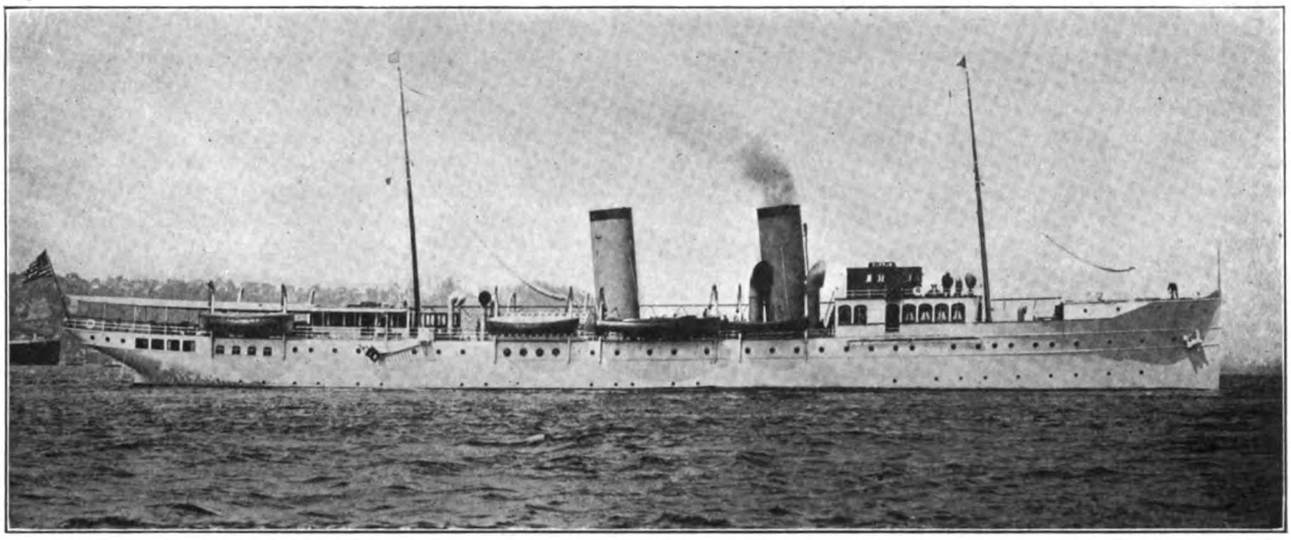

Fig. 1.—The Altered *Cyprus*

The present dimensions of *Cyprus* are: Length overall, 266 feet; length on the waterline, 250 feet; beam, 28 feet 6 inches; extreme draft, 13 feet 6 inches.

The lines show a vessel with fine entrance and easy run, considerable deadrise at all sections, a good hard bilge carried well toward the ends, ample freeboard and

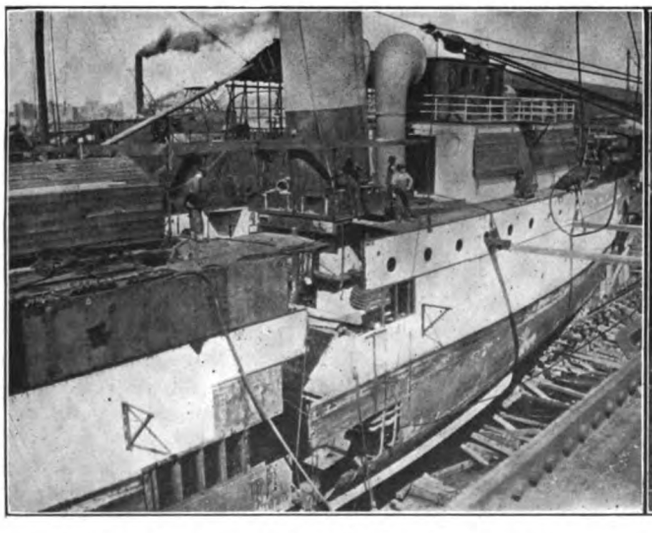

Fig. 2.—Starting to Pull the Two Sections Apart

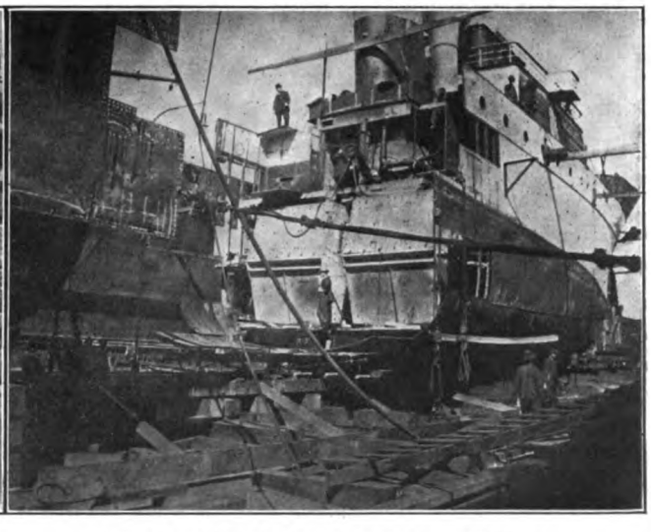

Fig. 3.—Original Hull Pulled Apart 35 Feet

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pleasing sheer, a full deck line associated with a pronounced flare forward, and a raised forecastle containing quarters for the captain, mate and pilots. From end to end the sides are carried up to the upper deck level, and to relieve the effect of this continued high side, large heavy plate glass windows 1 inch in thickness are placed in all the main saloons. Two large deckhouses of steel on the upper deck, the forward one containing dining room and pantry, the after one the wireless room and entrance hall, are so disposed and proportioned that with the two funnels of generous size and two pole masts equipped with wireless a most symmetrical and workmanlike appearance is secured, so that the remodeled *Cyprus* looks every inch a seagoing steamer.

The accommodations for the owner and guests comprise a total of thirteen large staterooms, none less than 10 feet in length, and for the use of the occupants of these rooms nine bathrooms are conveniently arranged.

An interesting feature in connection with the entire scheme of the quarters for the owner and his guests is that from each and every stateroom and living room, access may be had to all the other living rooms and staterooms without any necessity of going out on deck.

The arrangement of the living quarters for the crew and servants has been most carefully thought out, and notwithstanding that the total crew of 48 men has to be accommodated, unusually liberal quarters are provided. The valets and personal servants have quarters on the berth deck aft, where a separate bathroom is provided for their exclusive use. On the berth deck amidships, in between the engine and boiler room, are the quarters for the engineers, firemen, water tenders and oilers, these quarters having a separate mess room and two well-equipped bathrooms. On the berth deck forward are the quarters for a portion of the ordinary seamen with a separate mess room, toilet and wash room. Immediately aft of these quarters will be found the rooms of the cooks and stewards, these employees having a separate bathroom for their use. On the main deck forward the balance of the ordinary seamen are taken care of, the second mate also having a separate stateroom in this space. The raised forecastle contains a very comfortable stateroom for the captain with a private bathroom opening off the same, and also a stateroom for the first officer and for the pilot. On the main deck amidships is situated the officers' mess, which is readily accessible from the various officers' quarters. The galley for the crew, a bakery and a very large well-equipped separate galley for the owner are also located on the main deck amidships. On the main deck abreast the engine hatch on the port side is the chief engineer's stateroom, an excellent arrangement in every way.

The propelling machinery consists of two four-cylinder triple expansion, vertical inverted reciprocating engines having cylinder diameters of 16 inches, 26 inches, 30 inches and 30 inches, with a stroke of 24 inches. These engines, built by the Seattle Construction & Dry Dock Company, are designed to turn at 225 revolutions per minute; at 210 revolutions per minute each engine develops 1,500 indicated horsepower. Each of the main power units is supplied with a complete condensate system using condensers of 1,500 square feet of cooling surface each. There is also a Reilly multicoil feed-water heater with two long stroke feed pumps of the Blake type and two Davidson evaporators, each having a capacity of 12 tons in 24 hours. Fresh water is distributed in six tanks, making a total capacity of 110 tons.

Steam is supplied at 225 pounds pressure by four Babcock & Wilcox boilers having a total heating surface of 10,600 square feet. The boilers are fitted with Dahl burners, made by the Union Iron Works, San Francisco, for burning the fuel oil which is stored in eleven tanks having a total capacity of 360 tons. One donkey boiler of the Roberts type supplies enough steam to start the burners. This boiler has 600 square feet of heating surface and is situated for convenience in the after port corner of the main boiler room.

There is one steering engine of the Hyde type in the upper engine room, and a steam windlass of the Providence type, as manufactured by the American Engineering Company, Philadelphia. The refrigerating plant is very complete, comprising a one-ton Allen ice machine which has an auxiliary arrangement for making ice at the rate of 100 pounds per day.

The ventilating system contains five separate units, four discharging cooled air into the quarters and engine room, and one suction unit for the two galleys and bakery. Schutte & Koerting blowers maintain the proper draft and the air is cooled by passing it through a system of pipes in a tank through which sea water is circulated. The forced draft system in the boiler room is maintained by a Kerr turbine blower having a capacity of about 25,000 cubic feet per minute.

Electric current for the entire boat is supplied by two generators, one turbo-generator, 25 kilowatts, of the Allis-Chalmers type, and one 20-kilowatt generator with a reciprocating engine as manufactured by the General Electric Company. There is also a very powerful Marconi wireless apparatus and one 18-inch General Electric searchlight.

The propellers, of which there are two, are three-bladed with 8 feet 4 inches diameter and 9 feet 8 inches pitch. These give the boat a speed of about 18 knots when turning at 210 revolutions per minute. At the most economical speed, about 12 knots, the vessel has a cruising radius of about 7,000 knots.

The Boston Fish Pier

BY FREDERICK ROCHE

At Boston, Mass., the greatest fresh fish market in the United States, and the chief distributing point for the fresh fish supply of the entire country, the largest pier in the world devoted entirely to the fisheries has recently been completed. Constructed under the auspices of the Commonwealth of Massachusetts, the new pier cost $3,000,000 (£615,000). With its surrounding buildings on Northern Avenue, South Boston, the pier forms a city by itself. It is 1,200 feet long, 300 feet wide, of fireproof construction, being built of stone, concrete and brick. The plant of the Boston wholesale fish dealers, which stands at the head of the pier, includes the largest cold storage plant in the world.

The cold storage plant was built by the Commonwealth Ice & Cold Storage Company, a corporation in which the wholesale fish dealers are the largest stockholders. The plant of this corporation consists of a large cold storage building, having a capacity for over 15,000,000 pounds, and where 200,000 pounds of fish may be frozen each day; an ice factory where 360 tons of ice may be produced each day and 8,000 tons of ice stored; a power house which provides light, heat and water pressure for the entire pier and its surrounding buildings.

Cold Storage Plant

The buildings of the cold storage plant, built of reinforced concrete, tower above the other structures of the pier and are surmounted by a tower 100 feet high. The

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concrete walls are lined with cork board covered with cement mortar applied with cement guns, which insulates them from the heat of the atmosphere. The buildings are provided with an elaborate system of electric elevators and lifts of great speed and capacity.

The main building of the plant, situated directly on Northern Avenue, is 220 feet long, 100 feet wide and eight stories high with a basement, which makes it practically a nine-story structure. An archway through the center of this building provides entrance for teams and for freight cars, so that the latter may be loaded with goods from the freezing chambers. The freezing chambers, where the fresh fish are frozen, are kept at a temperature many degrees below zero, and fish remaining here for 24 hours are frozen solid. Upon being taken from the freezing chambers, the fish are dipped several times into water tanks, which cover them with a thin film of ice, after which they are placed in the storage chambers. The lower floor of the building, in which the ice is made, is used as a storage chamber, and its ceiling is 60 feet from the floor. The ice manufacturing apparatus is on the fourth and fifth floor. If the ice is to be used at once, instead of being lowered by elevators to the storage chamber below, it is hoisted to the top floor to the ice crushing room, where three large ice crushers are located. Before being delivered to the fish dealers or the fishing boats, the ice is run through these machines, and is ground into small bits ready for use. From the bottom of these machines the ice is delivered by gravity either into steel cars, running on an electric industrial railway over the roofs of the fish stores, or into specially constructed electric motor trucks. The steel cars convey it over the roofs to chutes leading into the ice boxes of the fish stores, while the trucks convey it to the vessels berthed at the pier.

MACHINERY EQUIPMENT

The whole plant is so planned and constructed that manual labor is done away with, automatic machinery taking its place. For example, coal is brought to the pier in barges, delivered into a car at the edge of the wharf, passes through an electrically operated crusher to an automatic scale, thence into a belt conveyor through a tunnel to the basement of the boiler house. A chain bucket apparatus lifts it from here into a coal pocket, situated above the four large vertical watertube boilers, which have a capacity of 2,000 horsepower. This coal pocket has a capacity of 500 tons, and is so arranged that it feeds the coal automatically into the furnace stokers, which are also automatic. The refrigerating machines, of which there are four at present, are in the machinery building.

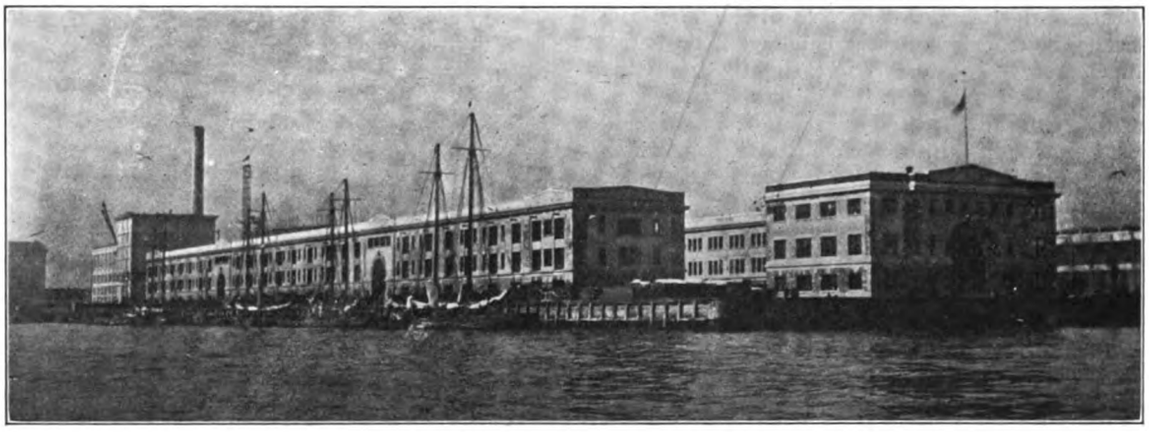

Fig. 1.—New Boston Fish Pier. View from the Harbor

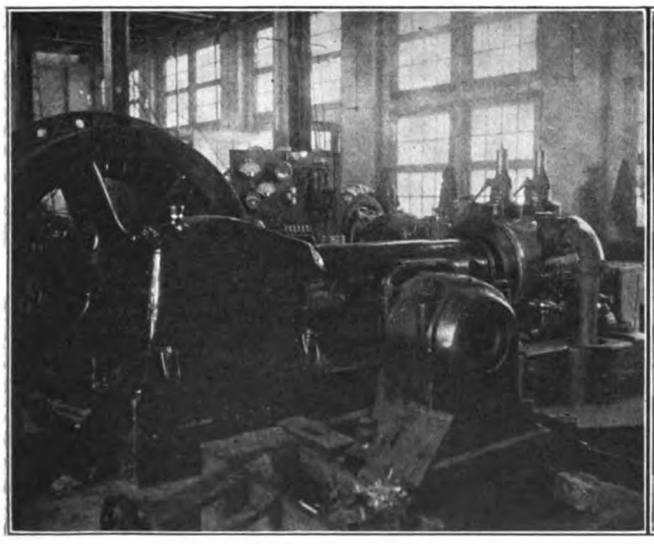

Fig. 2.—Generators and Switchboard

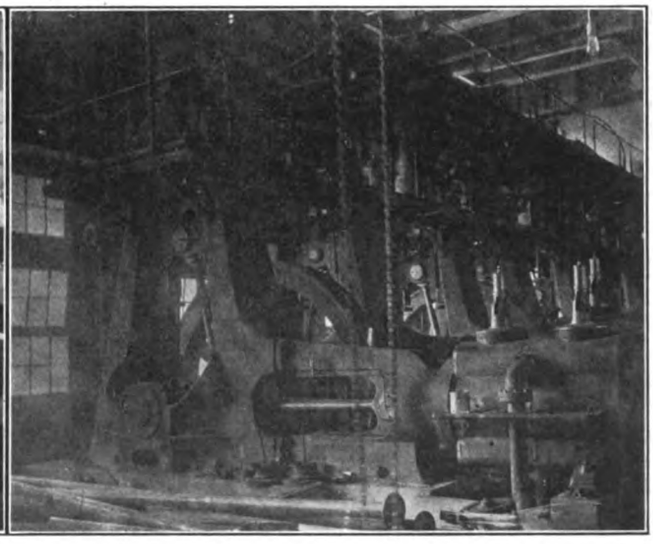

Fig. 3.—Refrigerating Machines

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Each machine has a capacity of 1,200 tons when operated at a very slow speed. They are driven with cross compound condensing engines, which in turn are operated with highly superheated steam at a pressure of 175 pounds per square inch.

Electric generators connected with the engine, and a large motor generator set, making a total of 1,000 kilowatts capacity, supply power and light for the entire plant, and are also used for charging storage batteries for the electric trucks used in ice delivery.

STORES

From the cold storage plant down the pier, in two parallel rows, separated by an avenue 100 feet wide, where all the teaming is done, are two three-story structures of concrete and brick which house the stores of the wholesale fish dealers. The exterior of these buildings is the same, but the interior of each store differs slightly from that of its neighbor. All were constructed on the same general plan, and with the same end in view. The floors and walls are of concrete, finished with enamel paint, which gives them the appearance of tile The floors slope gradually toward the center, where a drain is located, and each store is provided with a hydrant connected with the high-pressure salt water system, which is used daily for washing out the entire place. The offices of the 44 separate concerns in business on the pier are located on the second floor of the store buildings, facing on the center avenue before mentioned. The third floor, and in some cases the rear part of the second floor, is used for the storage of boxes and barrels.

THE FISH EXCHANGE

At the end of the pier stands the Administration Building, where the New England Fish Exchange, Boston Fish Market Corporation, Commonwealth Ice & Cold Storage Company, and the commission dealers have their offices. This building is square, constructed of brick and concrete, and like the stores is three stories high. The ground floor is taken up almost entirely by the New England Fish Exchange, founded in 1908 as the clearing house of the wholesale fish business. It is upon the floor of this Exchange that all the fish brought to the pier are bought and sold at auction. The room in which the buying and selling is done is a large square room well lighted by a number of small windows, as well as by a series of French windows, which take up practically all one side of the room toward the harbor. The center of the room is occupied by a big oblong wooden platform upon which the fishing captains stand when offering their fish for sale.

On Northern Avenue are located two parallel rows of two-story concrete buildings, one row of which is situated nearer the water houses and oyster and lobster dealers. The row on the opposite side of the street is occupied by ship chandlers, cigar stores, barber shops, restaurants and other trades people.

SUEZ CANAL IMPROVEMENTS.—To meet the impending competition from the Panama Canal, numerous improvements are being pushed forward on the Suez Canal. Last January the maximum draft of water was increased to 29 feet, as compared with 24 feet 4 inches when the waterway was opened in 1869. It is now announced that by means of powerful dredges another foot will be added to the depth early next year. The International Consultative Committee of Works, of which Sir William Matthews and Mr. Anthony Lyster are the British representatives, have produced plans which provide for a maximum draft of 40 feet throughout, while various sections of the canal are to be widened and lengthened.

The Harris Heavy Oil Marine Engine

For a long time marine engineers have been looking for a reliable heavy oil engine which is not only less complicated than the usual type of Diesel engine, but which is also without the serious faults which have so greatly militated against the widespread adoption of the Diesel engine on board ship. The general advantages of the Diesel engine, such as savings of weight and space and the remarkable economy of fuel consumption, are fully recognized, but so far these benefits have been obtained only by the use of complicated valve and maneuvering gear requiring delicate adjustment and constant attention and the use of extreme ranges of temperature in the working cylinders which are detrimental to the cylinder walls.

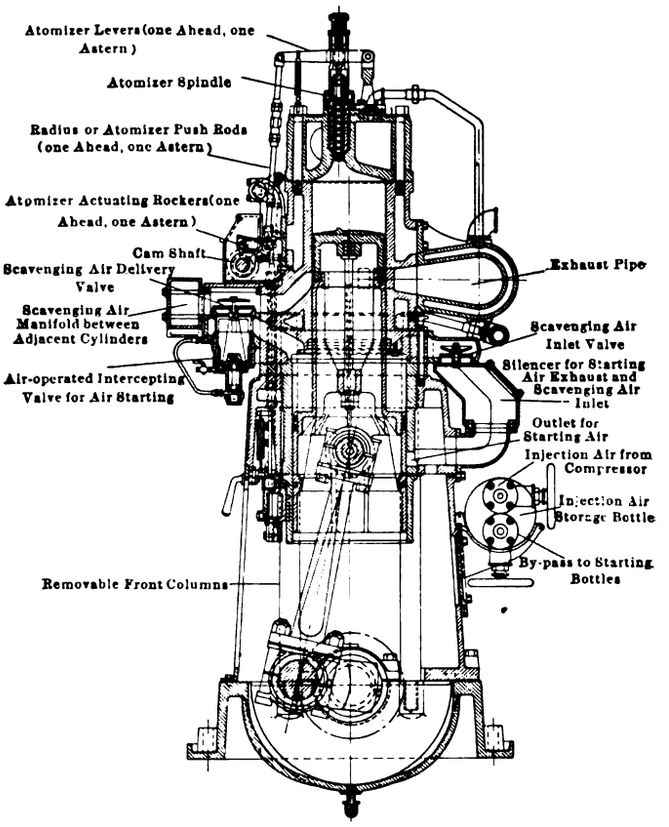
Atomizer Levers (one Ahead, one Astern)
Atomizer Spindle
Radius or Atomizer Push Rods (one Ahead, one Astern)
Atomizer Actuating Rockers (one Ahead, one Astern)
Cam Shaft
Scavenging Air Delivery Valve
Scavenging Air Manifold between Adjacent Cylinders
Air-operated Intercepting Valve for Air Starting
Exhaust Pipe
Scavenging Air Inlet Valve
Silencer for Starting Air Exhaust and Scavenging Air Inlet
Outlet for Starting Air
Injection Air from Compressor
Injection Air Storage Bottle
By-pass to Starting Bottles
Removable Front Columns

Fig. 1.—Cross Section of the Harris Engine

heads and pistons. A new heavy oil engine has been developed, however, by the Harris Patents Company, Philadelphia, Pa., which has apparently overcome many of these objectionable features to a great extent and which also brings out a number of new features both in the construction and in the method of operation which vastly improve the working of the engine.

The Harris engine is of the two-cycle type, built in two, four, six or eight cylinder units with a two-stage vertical air compressor worked off the crankshaft. In operation it is the nearest approach to the ordinary steam engine that we have yet seen. The entire control is by means of a single hand wheel which, through interlocking devices that preclude mistakes on the part of the engineer, enable him to start the engine on compressed air and gradually build up its operation on oil while still working on air, or to reverse it from full speed ahead to full speed astern in a few seconds. Further, the engine can be started immediately with the load on or it can be slowed down to a few revolutions per minute with the same certainty and with even greater ease than a steam

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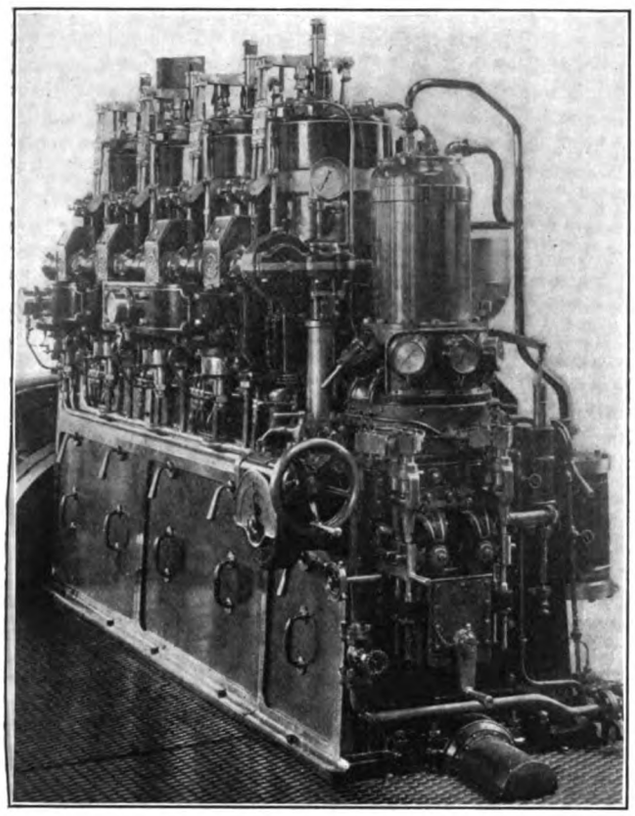

Fig. 2.—End View Showing Control and Air Compressor

engine of similar power. To fully understand how these results are obtained it is necessary to trace out the construction of the engine and its method of operation.

In place of the six or seven valves with their complicated valve gear, which are usually found in the cylinder head of a Diesel engine, the cylinder head of the Harris engine is entirely without valves, except for the single fuel atomizer by means of which the oil fuel is introduced to the cylinder. Stepped pistons are used, the enlarged extension of the main piston working in a cylinder below the working cylinder and acting not only as a scavenging pump for the adjacent cylinder, but also as an air motor for working under compressed air when starting or reversing the engine. In fact, the scavenging cylinders can

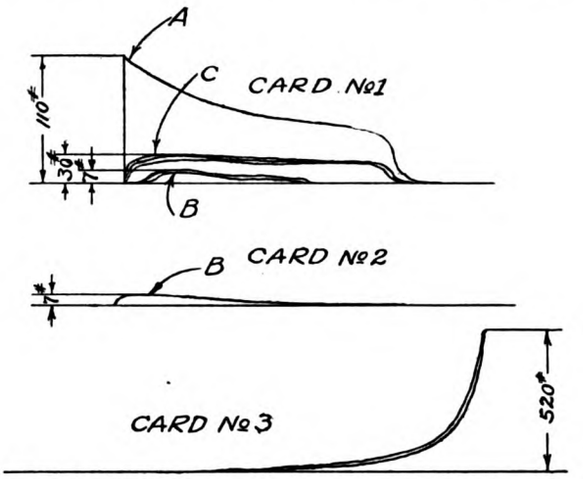

Fig. 4.—Indicator Cards from Harris Engine

still continue to run on compressed air while the working cylinders are performing their normal functions and operating on oil. The added advantage of this arrangement,

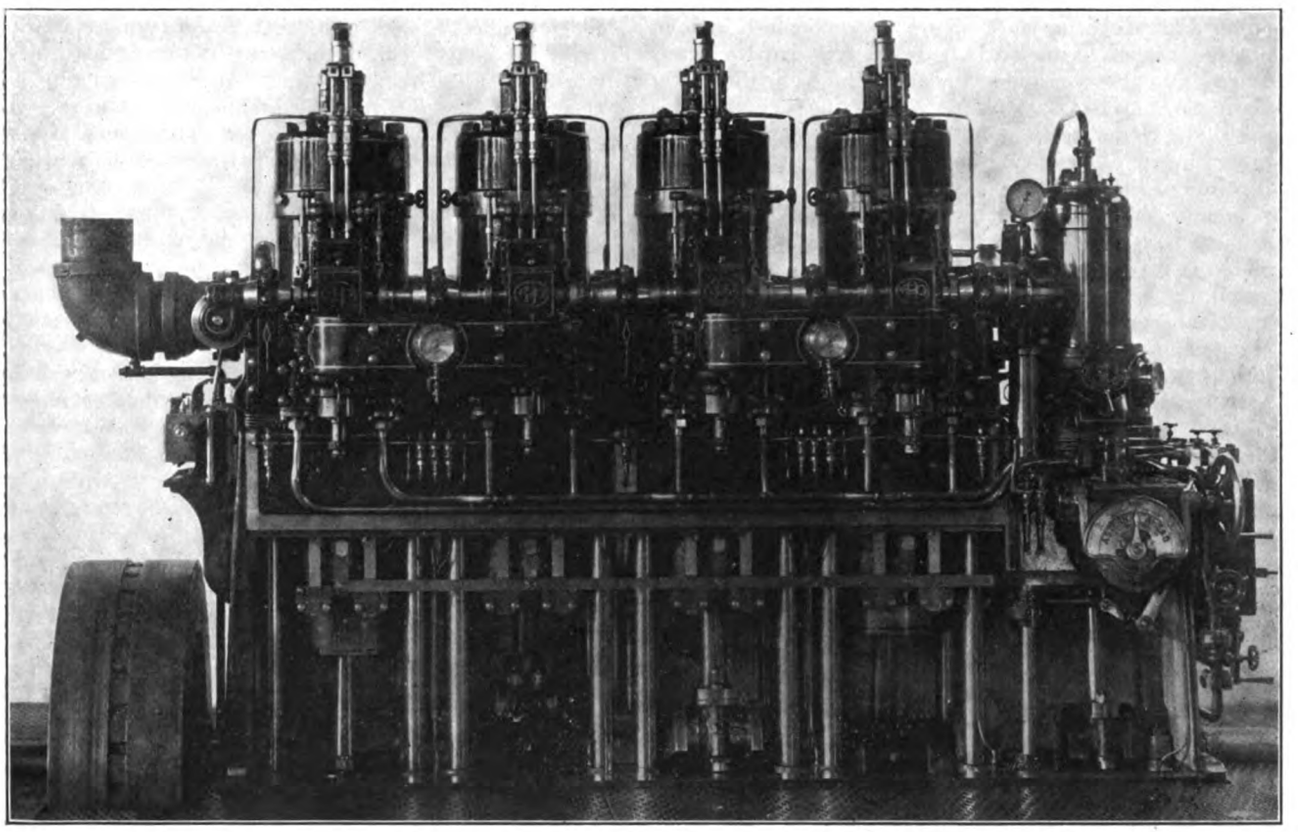

Fig. 3.—Four-Cylinder, 240 Indicated Horsepower Harris Heavy-Oil Engine (Front Removed)

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aside from the fact that the working cylinders are not subject to the low temperatures caused by working on compressed air, lies in the fact that each scavenging piston, having a greater area than the working piston, allows the engine to be started with 175 pounds air-pressure instead of the usual 800 to 1,000 pounds employed in Diesel engines, and, further, in starting and reversing the engine the atomizer valves do not operate while starting on air until the engineer wishes them to do so; consequently, all the usual bypass valves are eliminated and the temperature of the fresh charge of air in the cylinder is quickly raised, owing to the absence of the chilling effect caused by an air blast entering through the atomizer valve without fuel on each stroke while starting on air.

A better understanding of this arrangement can be obtained by referring to the indicator cards Nos. 1, 2 and 3 shown in Fig. 4. Cards 1 and 2 were taken from the scavenging or step cylinder while starting on air without pumping oil to the working cylinders. The line *A*, Card 1, represents the first outward stroke or initial inlet of air on the scavenging piston, showing that it requires only 110 pounds per square inch to act on the step piston to force upward the adjacent main working piston against its compression pressure of about 500 pounds per square inch. The reason why only a low pressure is required for this work is due to the enlarged area of the step piston against which the air expands. Line *B* represents the return of the above stroke of the step piston and shows that it performs its normal function of compressing a charge of scavenging air to 7 pounds per square inch. The line *C* represents the second and all consecutive upward strokes of the step piston, until the starting air is shut off by the engineer. The reason why only 30 pounds pressure on the step piston is required after the initial stroke is due to the fact that the pure air compressed in the working cylinder on the upward stroke of the piston expands on the downward stroke, thus assisting the air motor and recovering most of the work expended in compressing the air in the working cylinder. Card No. 3 was taken from the working cylinder at the same time that Card No. 1 was taken in the scavenging cylinder, and shows the compression and expansion of air in the working cylinder. Line *B* in Card 2 represented the normal function of the step piston delivered on the upward stroke, 7 pounds per square inch scavenging air pressure in starting air being admitted. This is the normal card which is given by the scavenging cylinder when running on oil.

The foregoing cards show that the step piston of the Harris engine performs three functions in three half revolutions, namely: first, one-half stroke downward, high-pressure air motor, 110 pounds; second, one-half stroke upward, scavenging pump, 7 pounds; third, one-half stroke downward, low-pressure air motor, 30 pounds.

Another advantage of the step piston construction in the Harris engine is that the step or lower piston and the wrist pin in it are not subject to high temperatures and consequent expansion, and, therefore, can be made a nice fit in the lower cylinder and act as a circular crosshead for the main piston. The main pistons can, therefore, have ample clearance between themselves and the cylinder walls, while the piston rings are called upon to perform only their natural function of preventing the escape of gases from the working cylinder past the piston. This construction, therefore, makes possible a smooth running engine without the noisy side flogging usually encountered in the ordinary "trunk" piston type Diesel engine.

In the construction of the engine the design of a marine steam engine has been followed as closely as possible, particularly as regards the crankshaft, bearings, connecting rods and lubrication. The cylinders are supported on columns and the engine may be operated either as a closed or open front engine, the front consisting of light panels which may be instantly lifted off by hand while the engine is running. A feature which will appeal to marine engineers is the fact that the front columns can be quickly removed and the entire crankshaft rolled out on the floor without further dismantling the engine or interference with overhead gear. The main bearings can be changed by simply removing the cap of the bearings without disconnecting the shaft or even taking the weight off the crankshaft. Lubrication of all parts except the cylinders, crosshead and wrist pins is by gravity, while a special oiling device is provided for the main bearings from below. The crank pit drains lead to a common pump, which circulates the lubricating oil to a receiver separator, extracting dirt and water and thence passing the oil to a filter and supply tank.

Along the side of the engine is a single cam shaft on which are two cams for each cylinder, one for ahead and the other for astern motion. These cams actuate rockers, which in turn actuate push rods bearing on them to lift the atomizers in the cylinder heads. The push rods, however, are not brought into play until they are moved out through a small arc by a system of rods and crank levers connected to the control wheel. If the control wheel is moved from mid-position toward the go-ahead position, it first admits air to an air-operated, intercepting valve admitting compressed air to the step piston, starting the engine on air. As the control wheel is advanced still further toward the ahead position the atomizer push rod over the ahead cam is moved out on its rocker and lifted by the cam, consequently admitting oil to the working cylinder. When the control wheel has reached the full speed ahead position the lower end of the ahead push rod has been moved out to the end of its rocker and receives the full lift of the ahead cam, opening the atomizer valve to its fullest extent. This arrangement, however, not only affects the amount of lift of the atomizer, but also the time of the lift, which amounts to the same thing as advancing the spark in an automobile engine, with its consequent advantages.

The various parts of the engine are shown in Fig. 1. Scavenging air is admitted to the working cylinder through ports in its circumference, while the exhaust gases from the working cylinder pass out through ports located opposite the scavenging ports and so arranged that the piston opens and closes them at the correct time during its travel. Besides the scavenging air and exhaust ports in the cylinders, there is only one other opening in the working cylinder, and that is a small opening in the cylinder head for the admission of oil from the atomizer.

Oil is supplied to the atomizer by a variable stroke pump for each cylinder. The variation of stroke is automatically controlled by a centrifugal governor, or the pumps may be operated by hand. The governor controls the discharge from the fuel pumps and does not lift the suction valves, as is commonly done in Diesel engines. Once the delivery pipes to the atomizers and suction supply from the service tank have been cleared of air there is always a solid stream of oil from the service tanks to the atomizers, and the slightest movement of the pump plunger produces a corresponding movement of the column of oil, forcing a definite quantity of oil into the atomizer, or, if the stroke be increased by the governor, a corresponding additional amount of oil would be supplied.

The oil is delivered from the service tank to the pumps

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under air pressure, which is taken care of by the engine, and may be anything from 5 to 100 pounds per square inch, making it immaterial where the service tank is located. There is no suction or pumping backwards, and if the governor cuts the pumps out of action entirely, the oil in the line is stationary and under pressure too ready to respond to the slightest movement of the pump plungers. It is claimed that hand pumping is necessary when starting, even after weeks of idleness. The stroke of each or all of the pumps may be varied either mechanically or by hand, all at once or each independently.

A unique device also permits the engineer to vary the speed of the engine instantaneously while the governor still maintains complete control of the operation of the engine at whatever speed the engineer wishes to operate it. It is also possible for the engineer to set the speed control at any predetermined speed before starting the engine, and when started it is claimed the engine will come to this predetermined speed and remain there. This speed control feature is especially useful in the case of a heavy head sea, when the engines are likely to race, and will perform the same work as that of an engineer at the throttle of a steam engine under similar circumstances.

In starting or reversing the Harris engine, air at from 175 to 300 pounds pressure acts on the step pistons, turning the engine over with its load on as long as the engineer desires to do so. After the first stroke, as previously explained, a pressure of only about 30 pounds is required; thus the engine is extremely economical in the use of compressed air when starting or reversing. After the momentum of the engine is built up by working on air, the oil can be given to the main cylinders, the air still being allowed to act on the step pistons. This will augment the power being developed from the main pistons, and, if it is desired, both the main and step pistons can be acting at the same time, the former on oil and the latter on air. The action of the air on the step pistons in no way affects the working conditions in the working cylinder, nor does it affect the step piston's normal function of acting as a scavenging pump. This feature is a distinctive advantage for a marine engine, as it allows the vessel to respond more quickly and with more certainty in a case of reversing from full speed ahead to full speed astern.

Reversing is accomplished by moving a single rod on each cylinder and does not require the movement of the cam shaft or the lifting of valve levers off the cams by compressed air, as is usually necessary in the purely Diesel engine. In the Harris engine the same wheel or lever which admits the starting air and the fuel oil controls the movement of the rods. The engine has exactly the same functions and power when running either ahead or astern. The simplicity of the reversing mechanism, the additional power from the air motors, the unchanged conditions in the working cylinders and the fact that it is not necessary to shut off the fuel when reversing, all combine to make the Harris engine extremely simple and easy to handle.

The two-stage air compressor driven off the main shaft is mounted at one end of the engine with a control valve on the suction. The inter-cooler between the first and second stages is in the water jacket of the second stage, while an aftercooler is fitted between the second stage and the air bottles with an independent water circulation. Starting air bottles may be charged by the main engine while running, through a special type of reducing valve or by an auxiliary compressor. Bilge and circulating pumps are mounted diagonally on the forward end of the bed plate, and are driven optionally by eccentrics, or of the rotary type, the valves being fitted with quick-opening valve boxes.

Two marine sets have been running in the builder's shops for some time with excellent economy and without any signs of breakdown or trouble of any kind. The larger set, shown in Figs. 2 and 3, is of 240 indicated horsepower. A smaller two-cylinder set has run successfully on Mexican crude oil of 19 gravity, a very thick, solid oil. The 240 horsepower engine weighs approximately 25,000 pounds. Its cylinders are 9 inches diameter with a stroke of 13 inches and at normal speed runs at 300 revolutions per minute.

Protection of Battleships Against Submarine Attack*

BY PROFESSOR SIR JOHN H. BILES, LL.D., D. SC.

Assuming that very serious damage will be done to a battleship or cruiser by the explosion of a torpedo, the question is what can be done to prevent or seriously reduce this damage. Subdivision naturally suggests itself as one means of minimizing the effect of this damage, but, when all that is possible in this direction has been done, there seems to be no great certainty that a battleship will be still a formidable fighting machine after having received the successful contact explosion of a 21-inch torpedo. Can we do anything in addition to subdivision to preserve the ship for effective fighting purposes?

To some it may seem that the readiest way to approach this problem is to clothe the bottom of a 25,000-ton battleship of the latest pattern with armor, and to increase her fulness sufficiently to allow her to carry this armor, letting everything else remain unaltered. The only considerable effect will be to reduce the speed by 2 knots.

Briefly, the points for discussion are as follows:

(1) Is 4-inch armor sufficient protection against torpedoes to justify its adoption in battleships of the class of the later dreadnoughts?

(2) Is the submarine menace of sufficient importance to justify the adoption of 4-inch armor protection on the bottom?

(3) Is the submarine menace of sufficient importance to justify the building of smaller, slower battleships of, say, 16,000 tons displacement of 18 knots, having six heavy guns each instead of eight or ten, as in the larger ships?

(4) Is the method of applying armor to the bottom of sufficient value in itself to justify the adoption of a form of ship which offers greater resistance than the ordinary form?

These are some of the points which suggest themselves for discussion. The form and arrangement of existing ships, though not revealed to us by the Admiralty, may be considered, for this purpose, as sufficiently well known to many to make it unnecessary for a third design to have embodied in this paper. If it should seem to be desirable to further consider this question of protecting battleships from submarine attack, it will be necessary to determine by experiment the effect of the explosion of a torpedo upon armor attached to a ship. If the submarine menace is judged to be really serious, the necessity for carrying out such experiments seems to be undoubted.

DELIVERY OF THE ARGENTINE BATTLESHIP RIVADAVIA.—The Argentine battleship *Rivadavia*, constructed at the Fore River shipyards in Quincy, Mass., was turned over to the Argentine government August 24.

* Extract from a paper read before the Institution of Naval Architects, Newcastle-upon-Tyne, July, 1914.

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The Watertight Subdivision of Ships and the Effect of Bilging—V

BY A. L. AYRE

The conditions contained in the above example and calculations to a large extent appear to agree with those occurring in the lamentable *Titanic* disaster, and it is quite easily seen why that vessel foundered after having a similar amount of her length exposed to the sea. The loss of the *Titanic* was one occurring under most abnormal circumstances in almost every respect, and appear to be such that could not with reason be fixed as the standard of test for efficiency in watertight subdivision. It does appear, however, that, without admitting these abnormal circumstances as being the standard test, something further may be done in the way of increasing the efficiency of the subdivision in very large vessels where a large number of lives and much valuable property are involved. Even if we presume that the shell damage had only extended over one-half of the length of the plating which was taken in the foregoing example, it is quite likely that three compartments would have been flooded instead of four, and while the damage itself would not have been so abnormal, yet the effect would have been quite as dangerous, either from the points of view of buoyancy and trim or straining.

Centerline longitudinal bulkheads have been advocated as a further means of subdivision, and while their dangerous effect had been dealt with in the case of an earlier example it will be interesting to note their effect in the case of the large vessels taken in the latest example. We will assume the starboard side to be bilged and the port side remaining intact. The amount of lost buoyancy and lost area of waterplane will be now exactly half in each case, these becoming, respectively, 6,382 tons and 7,808 square feet. The area of the intact waterplane will now be 49,280 — 7,808 = 41,472 square feet.

The amount of mean sinkage is now found by

$$\frac{6{,}382 \times 35}{41{,}472} = 5.38 \text{ feet, depth of layer of sinkage.}$$

Correcting for the difference in area of waterplane within the depth of the above layer, we can say 5.20 feet equal corrected mean sinkage $30 \times 5.20 = 35.2$ feet mean draft in damaged condition.

In considering the question of trim (presuming the vessel to remain in the upright position transversely for the time being), vast differences are found in the relative figures throughout the calculation, and the trimming moment is found to be 60 percent less than before, while the *M. C. T. 1"* is found to be 44 percent greater. The resultant effect of these two differences is that the total amount of trim is 72 percent less, which, together with 58 percent less mean sinkage, produces the waterline $W_2 L_2$ in Fig. 14, which will be seen to be vastly different to $W_1 L_1$ produced by the calculations based on both sides being bilged.

It is at once seen that a very great advantage results from the point of view of trim, owing to this further subdivision of the vessel. We may now take the more important effect of the longitudinal bulkheads on the transverse stability of the vessel. It has been seen above that for

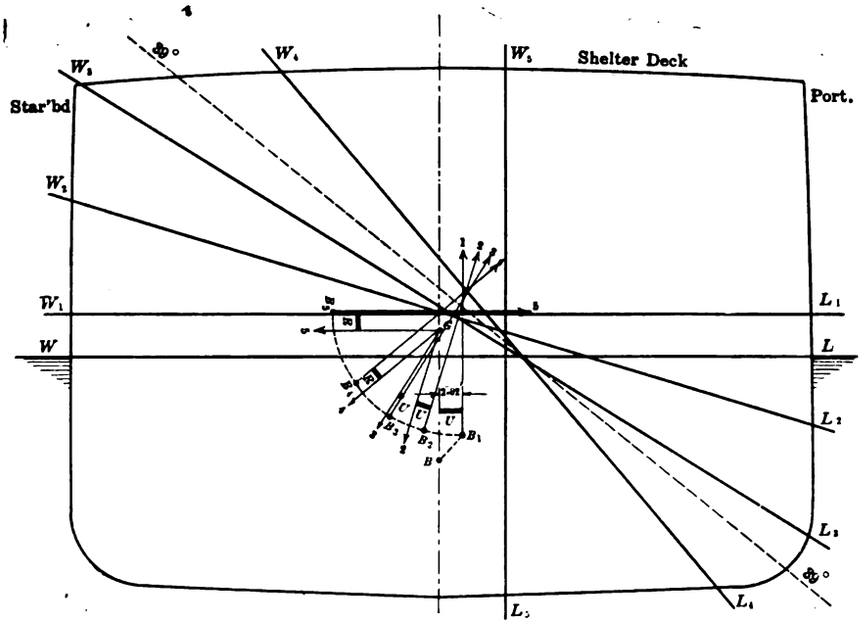

Fig. 15

this condition the amount of lost buoyancy is 6,382 tons. The center of gravity of this buoyancy lies at a position which is 15.1 feet from the centerline out to starboard. The net area of intact waterplane, as in the previous case, is 49,280 — 7,808 = 41,472 square feet, and the center of gravity of the lost area is 18.4 feet from the centerline out to starboard.

Owing to the withdrawal of waterplane area on the starboard side the center of gravity of the waterplane will move out to port to a position equal to

$$\frac{7{,}808 \times 18.4}{41{,}472} = 3.47 \text{ feet from the centerline,}$$

and which can also be taken to represent the position of the center of gravity of the added layer. We therefore see that 6,382 tons of buoyancy are lost at a point 15.1 feet out on the starboard side, and added at a point 3.47 feet out on the port side. The total shift is therefore 18.57 feet, and the moment of transference $6{,}382 \times 18.57 = 118{,}400$ foot-tons.

This moment of transference is also equal to an upsetting moment of statical stability. Dividing this moment by the total displacement we obtain the new position of

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the center of buoyancy for the upright condition, and measured relative to the centerline out to port 118,400 ÷ 40,500 = 2.92 feet, and which is also equal to an upsetting lever of stability acting on the vessel in the perpendicular condition.

While the holds are filling the waterline is rising and the vessel inclining to port. If we imagine the sinkage to first of all take place vertically to its full extent, as

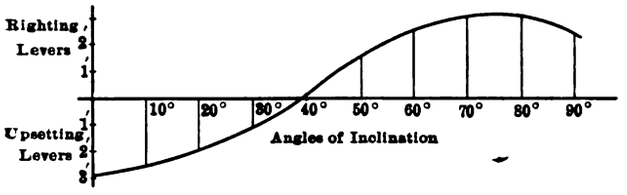

Fig. 16

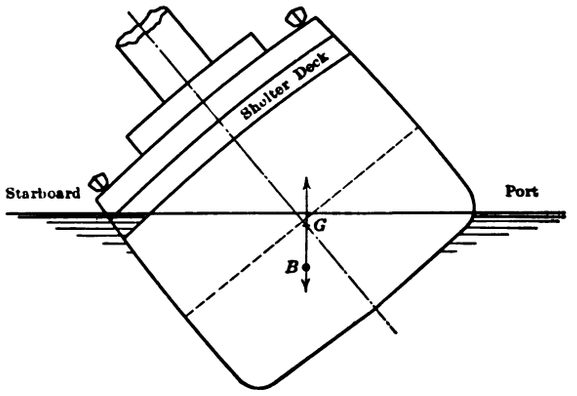

Fig. 17

above given, *i. e.*, 5.20 feet, we obtain the waterline $W_1 L_1$, as shown in Fig. 15. The center of buoyancy also rises on this account, and owing to the bilging of the starboard side only we have seen that it also moves out to port. The new position of the center of buoyancy therefore becomes that shown by B_1 in Fig. 15. Let us now consider the inclination to port. Fig. 15 shows the relation of the forces of gravity, given by calculations, at five positions, the corresponding waterlines, position of center of buoyancy and direction of gravity being shown by the respective figures 1 to 5. The first position is the one we have just imagined, *i. e.*, upright and total vertical immersion. Here we have the upsetting lever of 2.92 feet. The second and third positions also show upsetting levers (represented in the figure by the letter U). In the fourth position we see that the relation of the forces has changed, the force of buoyancy now appearing on the left-hand side of the gravity force and producing a righting lever (shown by R). The fifth position is one also having a righting lever.

The levers have been plotted on a larger scale in Fig. 16, which gives a clearer representation of the vessel's varying condition of stability, the upsetting levers being shown below the horizontal line and the righting levers above. The angle at which the vessel comes to rest—or angle of steady heel—is seen to be 39 degrees, and a corresponding waterline has been shown dotted in Fig. 15. This, of course, is an alarming angle of heel, as it results in the vessel's decks being absolutely unfit for traffic, and serious interference with the launching of the boats to the extent of preventing many of them being launched at all. A better idea of the vessel's condition is given by Fig. 17, where the vessel is shown in the inclined position of 39 degrees.

It must also be remembered that the above calculated results are purely theoretical, and if we consider the combination of other possible effects, such as the entry of water through open sidelights into the remaining undamaged portion of the vessel, bad weather, etc., we must conclude that this calculated position is the most favorable possible, and even one which is extremely unlikely, and, further, that very few boats would be filled and launched before the critical inclination occurs.

Centerline longitudinal bulkheads are therefore a grave danger in a vessel of this class and in the event of such an accident as that described. Even without such bulkheads, and the vessel sinking by the head as described in the earlier portion of this example, there would be much better chances of the boats being all filled and launched before foundering, as the changing of trim would not have the detrimental effect as occurs owing to the change in inclination.

Of course, in vessels of this class it is not usual to have a combination of purely transverse and longitudinal centerline bulkheads; but it is more usual to fit watertight wing bulkheads forming side bunkers. In such a case we would probably have a centerline bulkhead extending from bulkhead "A" to bulkhead "C," and wing bulkheads extending from "C" to the after end of the boiler room, as shown in Fig. 18. In this case there would not be such a large amount of lost buoyancy, provided the starboard wing bulkhead remains intact, and the movement of the center of buoyancy to port and resultant inclination would be slightly less than with the centerline bulkhead extending over the whole length of the damaged space, although,

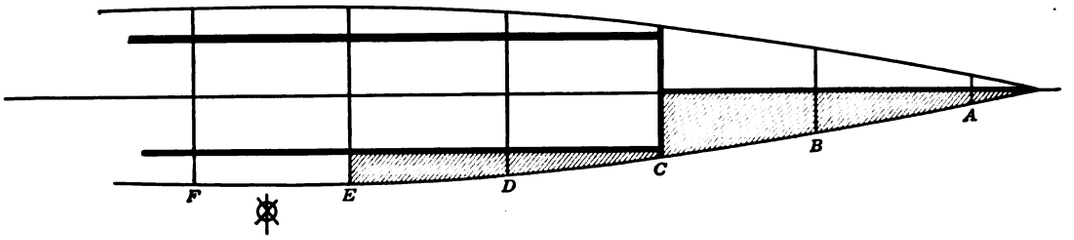

Fig. 18

of course, the amount of heel would still be highly dangerous.

To complete this example we will now consider the effect of a perfectly watertight deck fitted in such a vessel. So as to place the fullest reliance on such a deck it must be absolutely intact all fore and aft and having metal-to-metal connections in its construction and calked watertight; all hatchways should be trunked and watertight to, at least, the upper deck. Such a condition will be presumed in this portion of the example.

The deck to be made watertight should be one situated at a reasonable height above the load waterline, so that any damage of this nature will have as small a chance as possible of extending to the watertight deck and at once impairing its efficiency.

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In the present case, deck *D* is the one taken as being watertight. We have previously seen that the amount of lost buoyancy is 12,765 tons, and the net area of the remaining intact waterplane is 33,665 square feet, which gave a resultant mean sinkage of 12.46 feet, giving a new mean draft of 42.46 feet. The first effect of the watertight deck will be to reduce this amount of mean sinkage, because of the intact buoyancy lying above the deck being quite unaffected by the damage to the lower portion of the hull.

The mean height of the watertight deck in way of the damaged compartments is 39.5 feet above keel, and up to this point the area of a "damaged" waterplane would be used in determining the sinkage or to obtain the amount of buoyancy which is regained during immersion; after this point is passed, owing to the intactness of the buoyancy above the watertight deck, the full area of the waterplane must be used.

We should therefore first ascertain the amount of regained buoyancy at a draft of 39.5 feet. This, of course, represents a mean sinkage of 9.5 feet at this point, and by using the area of a "damaged" waterplane at half depth of this sinkage, the amount regained can be found as follows: 35,235 square feet (area at half depth) × 9.5 feet (depth) ÷ 35 = 9,566 tons of buoyancy regained at the point where the mean height of watertight deck enters the water; 12,765 — 9,566 = 3,199 tons, still to be made up by further immersion. Dividing this remaining amount by the full area of the waterplane (undamaged) we will obtain the additional amount of immersion required.

$$\frac{3{,}199 \times 35}{52{,}410} = 2.14 \text{ feet additional immersion;}$$

39.5 + 2.14 = 41.64 feet, which is the new mean draft in the damaged condition, but having the deck *D* perfectly watertight.

The trim may now be investigated, and in this respect it will be at once noticed that, as the new mean waterline at 41.64 feet draft passes through perfectly intact buoyancy, the question of trim is in this case quite equal to the normal, there being no damage effect of waterplane to take into account.

The center of flotation of the 41.64 feet waterplane is 7.8 feet aft of amidships, and the longitudinal metacentric height, corresponding to a perfectly intact waterplane, is 1,265 feet. The moment to change trim 1 inch is therefore

$$\frac{40{,}500 \times 1{,}265}{800 \times 12} = 5{,}337 \text{ foot-tons.}$$

Before the trimming moment can be ascertained the center of buoyancy of the new added layer must be found. We have already dealt with this layer in two portions—one, the lower, which is itself affected by the loss of buoyancy, and the upper, which is entirely composed of undamaged buoyancy. The former represents 9,566 tons, and has its center 81.2 feet aft of 'midships, while the latter contains 3,199 tons, and has its center at 7.7 feet aft of amidships. The two portions of the layer can now be combined and the center of buoyancy of the whole layer of sinkage found:

9,566 tons	× 81.2 feet aft	= 776,759
3,199 tons	× 7.7 feet aft	= 24,632
12,765		801,391

801,391 ÷ 12,765 = 62.8 feet aft of 'midships.

Now, seeing that the 12,765 tons of lost buoyancy originally contained in the damaged portion of the ship between bulkheads *A* and *E*, and having a center of gravity at 167 feet forward of 'midships, is to be compensated by means of the addition of an equivalent amount in the layer of immersion, but having its center of gravity at 62.8 feet aft of 'midships, the effect will be equal to a trimming moment of 12,765 × (167 + 62.8) = 2,933,397 foot-tons. This trimming moment divided by the *M. C. T. 1"* gives the total amount of trim: 2,933,397 ÷ 5,337 = 550 inches of trim. Distributing this trim in accordance with the position of the center of flotation of the 41.64 feet waterplane, we have

$$\frac{550}{12} \times \frac{392.2}{800} = 22.47 \text{ feet decrease of draft aft owing to trim.}$$

$$\frac{550}{12} \times \frac{407.8}{800} = 23.36 \text{ feet increase of draft forward owing to trim.}$$

41.64 — 22.47 = 19.17 feet, new draft aft.
41.64 + 23.36 = 65.00 feet, new draft forward.

The waterline corresponding to these new drafts is shown in Fig. 14 by $W_3 L_3$, and it will be seen that there is an enormous difference between this and the condition produced in the earlier portion of the example when no watertight deck was allowed for.

In spite of the serious damage, which has been presumed throughout this example, it will be seen that in the latest case the watertight deck has been the means of restricting the flooding so as to leave the vessel with quite a reasonable amount of reserve buoyancy as against certain foundering when without the watertight deck. A freeboard of about 22 feet to shelter deck remains, and which alone is ample proof of the effectiveness of the deck. The trim is, of course, abnormal, but in any case it is assured that the vessel will remain afloat and allow the passengers and crew being transferred, which is more than can be safely said in the case taken without the watertight deck, or should a list occur owing to central division by means of watertight vertical bulkheads fitted longitudinally. Further than this the vessel is in a condition permitting salving; the remaining freeboard will allow of the aftermost hold compartment being flooded up to the upper *B* deck so as to decrease the trim by the head. Although this would cause an additional mean sinkage of about 3 feet, there would be a total change of trim equal to about 22½ feet, so that the drafts would be amended to about 33½ feet aft and 56½ feet forward, in which condition there would be reasonable hope of the vessel steaming into sheltered waters to there permit of the damage being attended to, there still remaining a freeboard of 19 feet.

It is therefore seen that the perfectly watertight lower deck, dividing the vessel horizontally into two absolutely independent portions, is the most valuable means of watertight subdivision fitted in conjunction with transverse vertical bulkheads. With such a system the public would be able to safely accept a guarantee of unsinkability.

TYPE OF BOATS FOR THE NEW YORK STATE BARGE CANAL.—In a report just issued by John A. Bensel, state engineer and surveyor of New York, outlining the types of boats best adapted for the navigation of the new state barge canal, it is stated that the largest number of vessels will be for fleet service. They will be about 150 feet long and 22 feet beam, a size which permits the lockage of four at a time, one of the four being a power boat towing the other three. Another type of boat that will be used will be about 300 feet long with a beam of 40 to 43 feet. This type will probably be used for service on the Great Lakes. Mr. Bensel states that in vessels having a length of 300 feet, freight will be carried cheaper through the canal than in boats of smaller size.

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Economical Method of Handling Freight

Electric Storage Battery Trucks Installed by the Fall River Line Eliminate Congestion and Reduce the Cost of Handling Miscellaneous Package Freight

At piers 14 and 15, North River, New York city, which form the New York terminal of the New England Steamship Company, which operates fast passenger and freight steamships to Fall River, Mass., and Providence, R. I., an average of 2,300 tons gross of miscellaneous package freight is handled to and from the steamship company's vessels each day. The boats usually dock at the New York piers at about seven o'clock in the morning and leave again on the east-bound trip at half-past five or six o'clock in the afternoon. During the interval while the boats are at the piers, the entire west-bound freight must be unloaded and a complete cargo for the east-bound trip loaded on the boats. Until recently this freight was handled by hand trucks, and, on account of the increasing volume of freight handled, congestion on the piers resulted. Within the last year, however, this situation has been relieved by the installation of twenty Sprague electric freight trucks, by means of which it has become possible to keep the shippers' trucks off the pier and to load and unload the freight in much less time and at less cost than was possible with the former methods.

Fig. 1.—Electric Trucks Delivering Freight on Steamer from Receiving Platform

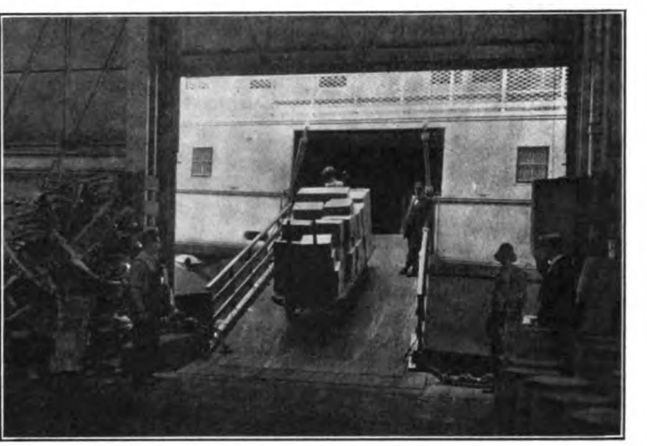

Fig. 2.—Sprague Electric Truck Ascending Steep Grade With Load

The Old System

With the old system, in order to keep the cost down to a minimum, it was necessary for nearly all of the shippers' trucks to go on the docks to receive or deliver freight. Those receiving inbound freight were driven to the point where their freight was stowed and were loaded direct from the pile of freight, except in cases where the dock was too congested to permit the shippers' trucks to drive to their freight without a long delay. In such cases, which were not infrequent, to give the shippers satisfactory service it was necessary to truck the freight by hand to the shippers' truck at the bulkhead. This required a number of extra men, and was very expensive to the company. The shippers' trucks delivering outbound freight were also driven on the dock to the gangway of the ship, where the freight was unloaded, weighed, checked and trucked direct to the deck of the ship by hand trucks. The number of shippers' trucks allowed to unload at one time economically was limited by the space directly in front of the gangway.

At certain times of the day, when the shippers' trucks were arriving at the dock in greatest numbers, in order to avoid too many trucks accumulating, which would cause a long delay to the shippers' trucks and a great congestion both inside and outside of the dock, it was necessary for the company to give the drivers help to unload their trucks quickly, and it also necessitated a large number of men with hand trucks to truck the freight on the ships, as there was no space available to pile the freight temporarily on the dock. Even when conditions were the best a trucker could handle but a small load, while at the time of high tide the grades up the gangways was such that the trucker required assistance.

Advantages of the Electric Truck

With the installation of electric trucks, however, this delay due to congestion has been reduced to a minimum, if not entirely eliminated, and a great reduction has been made in the cost of handling the freight by keeping the shippers' trucks delivering outbound freight off the docks entirely. As a rule, an average of 863 trucks a day delivered freight for the Fall River boat, and nearly as many delivered freight for the Providence boat. To handle this volume of freight in the limited time available without causing congestion, several changes were made in the method of receiving freight, in which the use of electric storage battery trucks formed a most important part.

The first notable change consisted in the construction at the bulkhead of the pier of a receiving platform one inch lower than the loaded electric truck. On this receiving platform is delivered from the shippers' trucks all of the outbound freight for both the Providence and Fall River boats. The platform is built in sections: the outer section, or that nearest the doors, is permanent and contains two scales at each door. The inner section is portable and is subdivided into five sections so as to make it possible to lift them out of the way when not in use. In the early morning these portable sections are lowered and the outbound freight received is stowed on them, after it has been weighed and checked. Meanwhile the electric trucks are engaged in unloading the ships.

Receiving Platform

As the freight is transferred across the receiving platform, it is sorted according to railroad divisions, so that

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each electric truck can be given a full load of freight to be stowed in a certain section of the boat. For instance, on the Fall River boat the forward end of the deck on which the freight is stowed is reserved entirely for freight destined for Fall River; aft of this, at either side of the boat, are sections reserved for freight destined for way points beyond Fall River; further aft, space is reserved for carload shipments and merchandise for Boston, while separate spaces are reserved for perishable freight for both Boston and Fall River. Another section of the deck, close to the gangways, is reserved for freight bound for doors at a time at the receiving platform without causing delay to the shippers' trucks, but as the day goes on the shippers' trucks accumulate faster, and when they cannot be taken care of by the doors already open, extra doors are then thrown open so that the shippers will be permitted to unload their trucks without delay. As many as twenty trucks can be unloading their freight at the same time when all the receiving doors are open. At either end of the platform is a receiving door without a platform to receive full load shipments direct from the shippers' trucks to the electric truck. This is to avoid the handling of

Fig. 3.—Stowing Freight on Steamer

Fig. 4.—One Electric Truck Load Equivalent to Twelve Hand Truck Loads

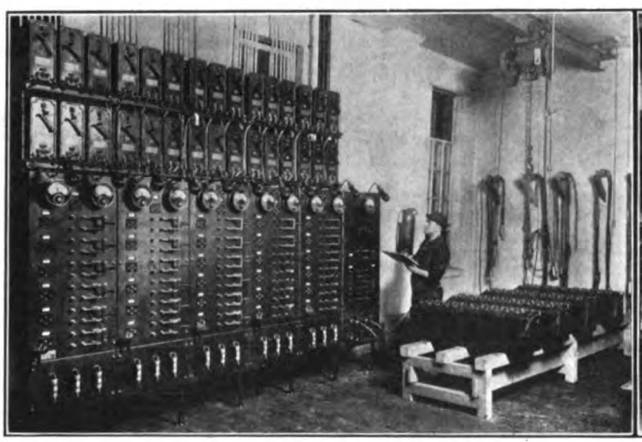

Fig. 5.—Charging Board for Storage Batteries

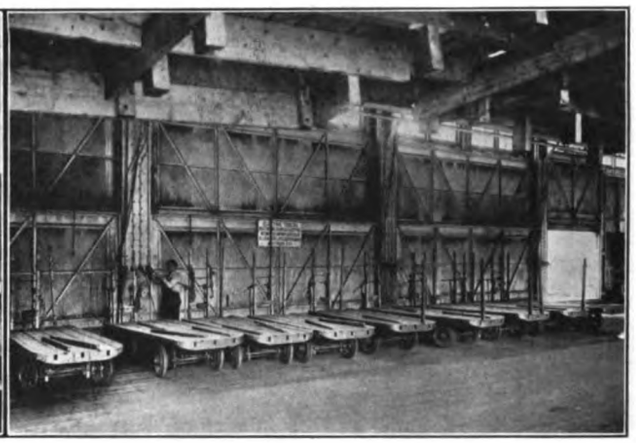

Fig. 6.—Freight Trucks Being Charged

Newport. By loading the boats in this way, the freight may be quickly transferred to trains at the other end of the line.

By the time the portable section of the receiving platform is filled with outbound freight a sufficient amount of inbound freight has been unloaded from the ship and stowed on the pier to make room for stowing outbound freight on the ship, and then, while most of the electric trucks remain unloading the ship, a few are assigned to transfer the freight from the receiving platform to the ship as fast as it is received. No special effort is made to transfer the freight accumulated on the platform until the ship is nearly or completely unloaded. As soon as a portable section is unloaded it is hoisted out of the way and the freight loaded direct on the electric trucks.

In the morning hours the outbound freight is not delivered as fast, and can be easily received at one or two freight across the platform which does not require weighing.

In unloading the ship the electric truck is loaded with freight with little regard to marks or destination. This freight has to be sorted as it is stowed on the dock, and it is sometimes necessary for the electric truck to go to a number of piles of freight in order to distribute its load in the proper places on the dock.

Savings Effected by the New System

It is almost impossible to determine the exact saving effected by the use of these trucks at this time, on account of the wide variation of conditions and the limited time the trucks have been in service, but from the observations thus far made it is safe to say the savings will mount well into large figures. Different kinds of freight are handled on different days, and the tonnage varies to a great extent

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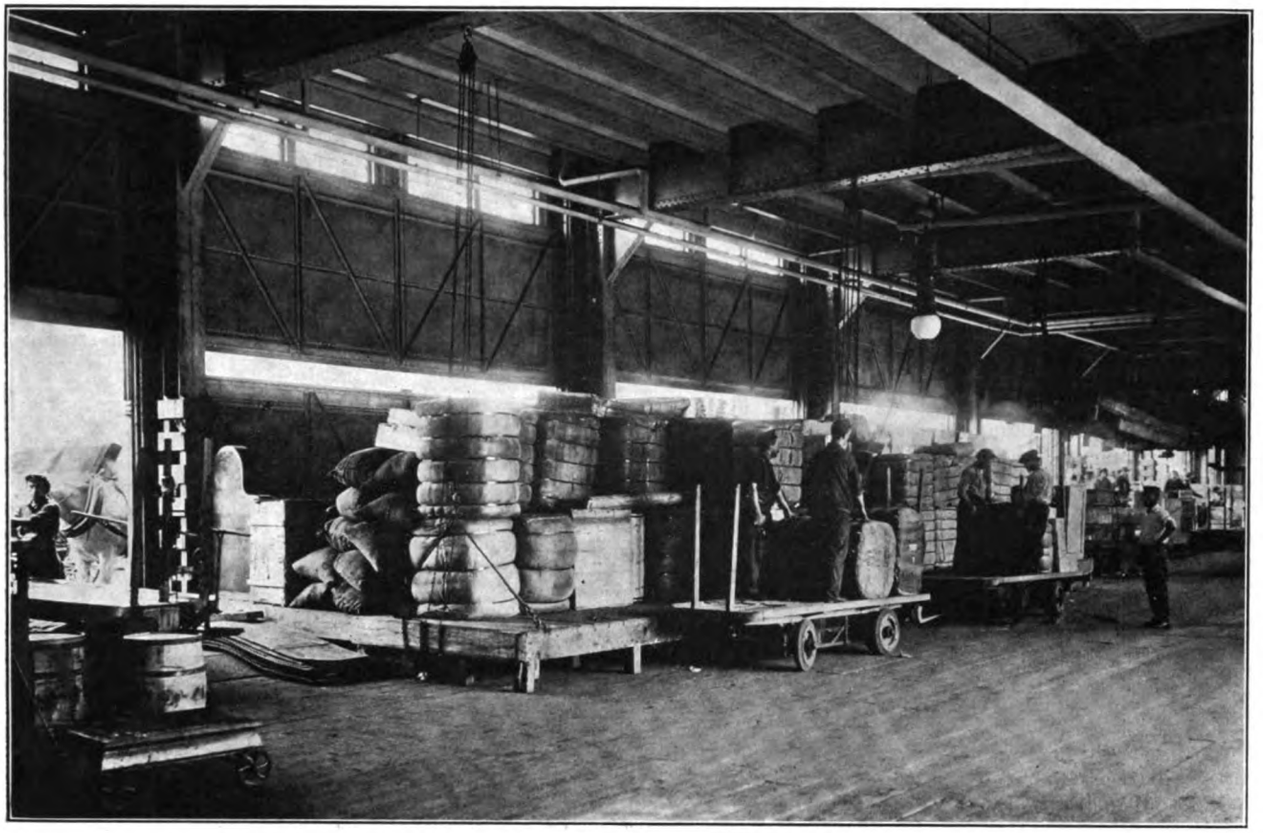

Fig. 7.—Sprague Electric Trucks Receiving Freight from Receiving Platform for Transfer to Steamer

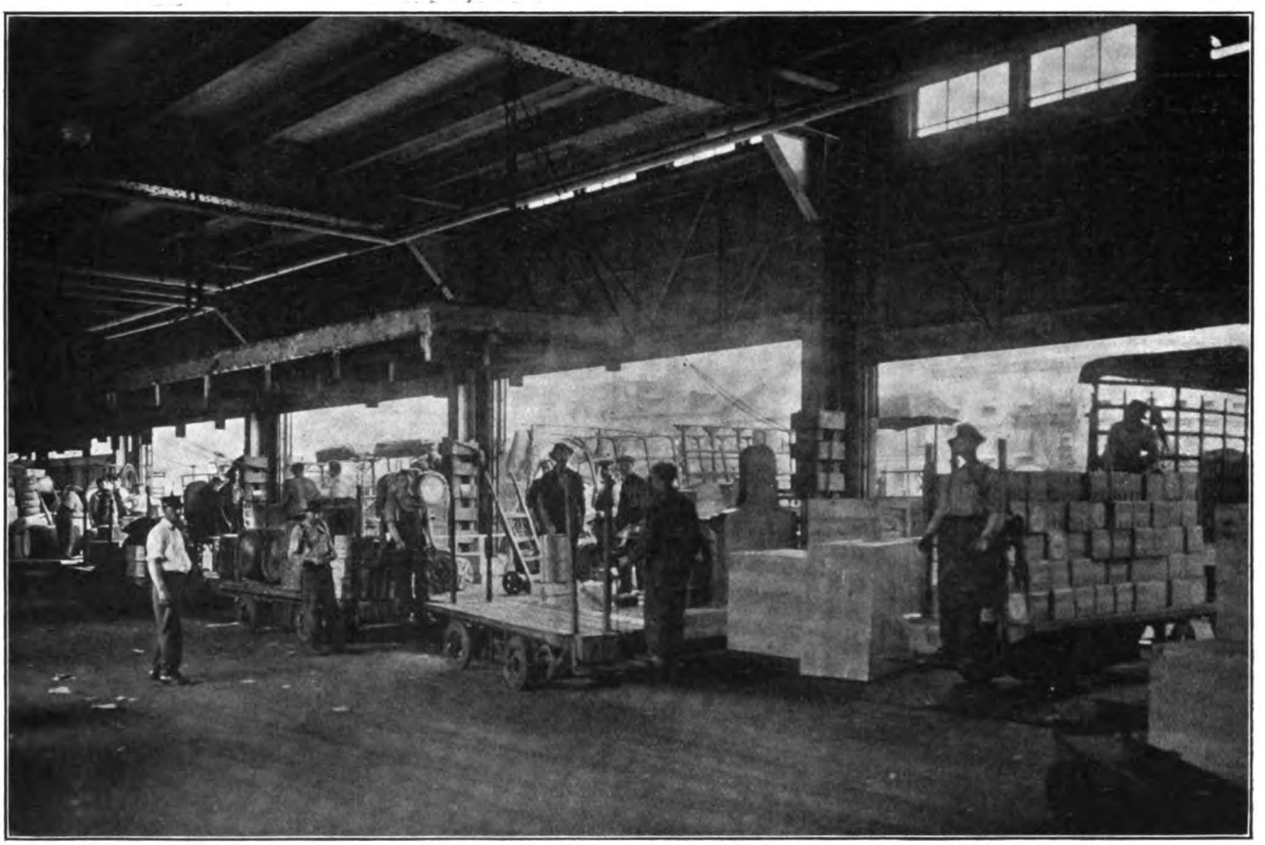

Fig. 8.—Electric Trucks Receiving Package Freight Direct from Shipper's Truck and from Platform

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at different times of the year. Furthermore, the tides vary each day, more men are available on some days than on others, and there are several other variations, which all have some effect on the actual cost of handling the freight.

As can be seen from Fig. 2, there are times when the grades up the gangway are as high as 25 percent, due chiefly to the tides. Steep grades of this kind, however, can be negotiated by an electric truck with a full load, while with the hand trucks it is absolutely impossible for one man to take an ordinary hand-truck load up such grades. In all classes of freight the electric truck will carry several times the amount that one man can carry with a hand truck, and, furthermore, it will travel three or four times as fast. This is clearly demonstrated in Fig. 4, which shows an electric truck loaded with forty-eight cases of canned goods, and twelve hand-truck loads of four cases each of the same kind of freight.

Another economy is effected when a great amount of freight is to be transferred from barges or lighters to the steamships. By using the electric trucks it is not necessary to warp the barge to the side of the ship, so that the freight can be transferred directly to the ship without a long trucking distance. The barges can be unloaded at any point along the pier wherever they happen to be placed, and the freight can be easily transferred from them to the ship by means of the electric trucks. Finally, a great saving is made in the above method by keeping the shippers' trucks off the docks, and thus making greater space available for storing freight.

Steel Derrick Barges for the Pennsylvania Railroad

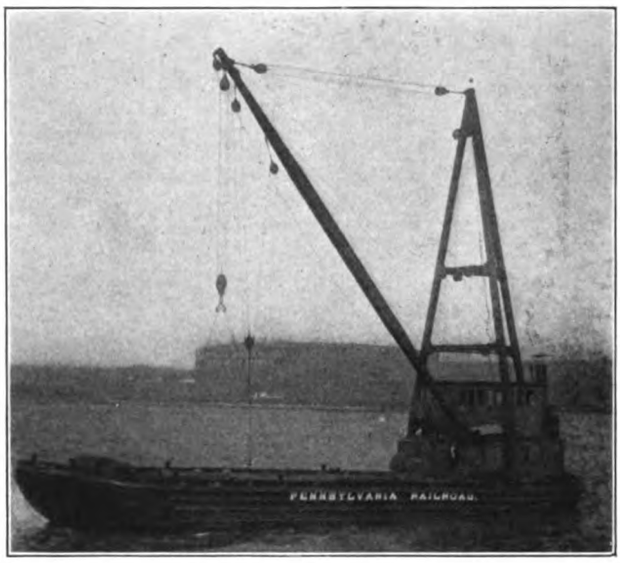
During the year 1907 the Pennsylvania Railroad Company built eight steel derrick barges, principally for the transportation of structural material, large pipe and miscellaneous heavy material. Five more barges of similar type have recently been added to the company's equipment, bringing the total number of derrick barges operated by the company up to seventy-two.

In the new barges the hull is formed with a view to easy towing; the corners of the deck have been rounded so as to lessen damage done to piers and other boats while maneuvering, and rounded steel fenders are fitted along the sides for the same purpose. The heel of the boom is stepped ten feet above the deck, so that freight can be piled high close up to the mast, which is of considerable advantage where long structural material is carried. The hoisting ropes lead directly from the mast head blocks to the hoisting engine drums, avoiding quarter blocks, and unusually large sheaves are used to reduce the bending strains in the ropes; the sheaves are fitted with roller bearings.

The hull is entirely of steel, 100 feet long, 34 feet wide and 9 feet 6 inches deep amidships. The hull plates are ⅜-inch thick and the deck plates ⅜-inch thick supported by 9-inch channel bars 2 feet apart. A truss frame is built 6 feet each side of the centerline extending under the deck storage space and distributes the deck strains to the vessel's framing. The only wood used in the construction is the small rail around the edge of the deck to prevent materials falling overboard.

The mast is of the A-frame type without rope back, stays or shrouds. Each leg is formed of two 12-inch channels with plate on one side and lattice bracing on the other; the heel of the mast is carried on three columns of similar construction, extending to the bottom of the vessel, and as the boom heels at the heel of the mast it will be noted that the racking strains are confined to the derrick structure and the supporting columns require no lateral bracing other than that necessary to overcome the small lateral strains imposed when the vessel lists.

The boom is 78 feet long, formed of four angle bars 3½-inch by 3½-inch with plates on three sides and lattice bracing on the under side. The main hoist is a five-part fall of ⅝-inch wire rope with a capacity of 10 tons at 36 feet per minute. The auxiliary hoist is a single part ⅝-inch rope lifting two tons at 180 feet per minute. The hoisting engine is of unusual design; each hoisting drum is located directly beneath the mast head purchase block that it controls and is operated by a single gear reduction from a jack shaft common to all, the jack shaft being coupled



Pennsylvania Derrick Barge

direct to the crankshaft of the engine; the latter is of the double cylinder type, 9-inch diameter, 10-inch stroke. The boiler is of the usual vertical type with 10.5 square feet of grate surface and 330 square feet of heating surface; a pump is installed that will deliver one good size fire stream and has suction pipe connections to each compartment for pumping the bilges.

The refinements incorporated in the design, such as large sheaves with roller bearings, direct leads for the ropes and small number of driving gears, as above mentioned, have all contributed toward the efficiency of the mechanism, and on recent test it was found that 56 percent of the indicated horsepower of the engine was utilized in useful work.

The designs were prepared by the Pennsylvania Railroad Company and three of the barges were built by the Pusey & Jones Company and two by the Ellicott Machine Corporation.

FAMOUS WINDJAMMER A WAR PRIZE.—The 3,609-ton steel London ship *Brilliant*, one of the last sailing vessels owned by the Standard Oil Company, found the transition to the German flag an unlucky one. She was recently sold to Hamburg interests, converted into a motor ship at New York, renamed *Perkco*, and sailed on July 18 for her new home port. On August 5 she was captured by a British cruiser in the English channel and taken into Dover, being probably the first important prize of the great war. The *Brilliant* for years has been engaged in carrying case oil from New York to the Orient, and is one of the best known windjammers afloat.

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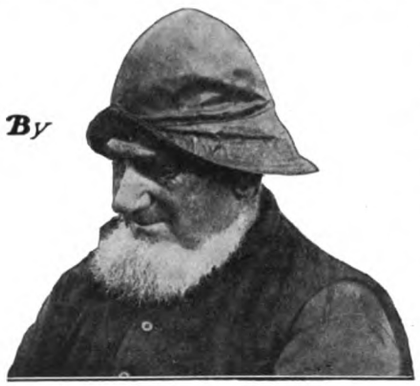
Economy Talks By "Old Scotch"



Rules for Firing Scotch Boilers

I think when we left off last month we had just quit "rastlin'" with carbon, oxygen and other such stuff that goes into furnaces. I have tried to point out how necessary it is to get these important elements mixed up in the right proportion, and now we must see how it is done practically.

You have seen why it is as important that some air comes in above the grates as it is to have it come in through the grates. I will also suggest right here that it is mighty important not to have too much air, as in that case too great a quantity of oxygen is being supplied for the proper mixture of carbon dioxide and the result is great waste. Some firemen are gradually learning that they must not keep the furnace doors open too long, as that is one of the principal causes of loss of efficiency in coal burning, but if you want to get in on that ten percent rake-off, the first thing to do is get in among your men and train them how to fire properly.

Losses in the boiler room cannot be recovered in the engine room, and if you don't get your money's worth out of the coal in your boiler furnaces you have practically thrown your chances of any part of the ten percent rake-off overboard. Put this up to your firemen at the start.

Suppose you have four three-furnace boilers and three men on a watch, so that each man has to handle four fires. Teach them first that only one fire door must ever be opened at the same time, and secondly that each furnace must be charged in a regular order. Let each one of the three firemen have his furnaces numbered 1, 2, 3 and 4. Call your firemen A, B and C, as that is simpler than Murphy, O'Connor and Maguire, or other names like those. Arrange a system so that at regular intervals A charges his No. 1 furnace, to be followed by B with his No. 1 furnace, and then by C with his furnace of the same number. Let A then charge his No. 2 furnace, and so on right down the line, and keep it up regularly, the time between firings being regulated by the demand for steam from the mill in the engine room.

Don't let them put in more than two shovelfuls of coal at each firing and have them close the door between the two. Tell them to scatter a shovelful of coal uniformly over the surface of the fire, and not to put it all in one bunch. The first man who tries to build up a crown-sheeter so that he can sit down and smoke for ten or fifteen minutes should be drawn and quartered, or given some other light punishment of that sort. If you're running natural draft don't let 'em ever carry the fires over 8 or 10 inches thick, for if you do you'll be turning out more of that bad smelling gas I was telling you about and wasting a whole lot of heat units. If you're running with the blowers on you might let 'em carry the fires a foot thick, but no more.

Don't let any of your Irish giants get too busy with his slice-bar, unless you have pretty rotten coal, and have to bust up a few clinkers with that delicate instrument. There's naturally a whole lot of live coals dislocated and prevented from doing useful work by too much use of the slice-bar.

The fires should be kept as nearly level as it is possible to make them, and to do this they should be leveled off occasionally with a hoe or light rake. If your men get skillful in spreading the coal over uniformly you will not have to use the hoe or rake very much. The main object of keeping the fires level is to avoid holes and places where the air can sneak through easier than at other parts of the surface. Give every particle of air the same amount of work to do in climbing through the burning coal, and then you will succeed in carrying fires which will burn coal economically.

Don't wet the coal down, as many engineers like to have done, in the mistaken idea that it burns better. If the coal is so finely powdered and the draft is strong, it is all right to sprinkle a little water on it, so that the loose particles will not be carried up the stack unburned. If the coal is lumpy have the "snipes" break it up before it is shoveled into the furnaces. You should never use lumps much larger than a baseball, if you know how large that is. Perhaps some of you will understand it better if I say a highball.

If the fires are not being forced very strongly, pull the lumps out of the ashes and burn them over again, as there is often a lot of good fuel thrown away through the ash ejector.

It isn't necessary maybe for me to tell you to have the fires cleaned, and that this operation should be done as rapidly as possible in order to keep as much cold air out of the furnaces as you can. Don't stick too closely to any regular time for cleaning fires, but clean them when it is plain that they need cleaning. Don't under any circumstances clean more than one fire at a time. Above all things, don't let ashes collect in the ash pans; keep them hauled and clean all the time. If you don't the air does not have a chance to get at the backs of your fires, and it is mighty important that the fires at the backs of the furnaces burn as brightly as in the middle or front. Keep in mind all the time that the great economy in fuel is to burn it properly.

These rules that I have laid down may sound a little school-boyish, but it is in carrying them out properly that you will save coal, and coal means money, both for the owners and yourselves. In the next chapter I am going to inflict upon you some more suggestions about combustion, and then proceed with some other ideas for economy about the boilers. You must remember that it is the little details in connection with your business where savings are to be made. Yours for Economy,

Old Scotch

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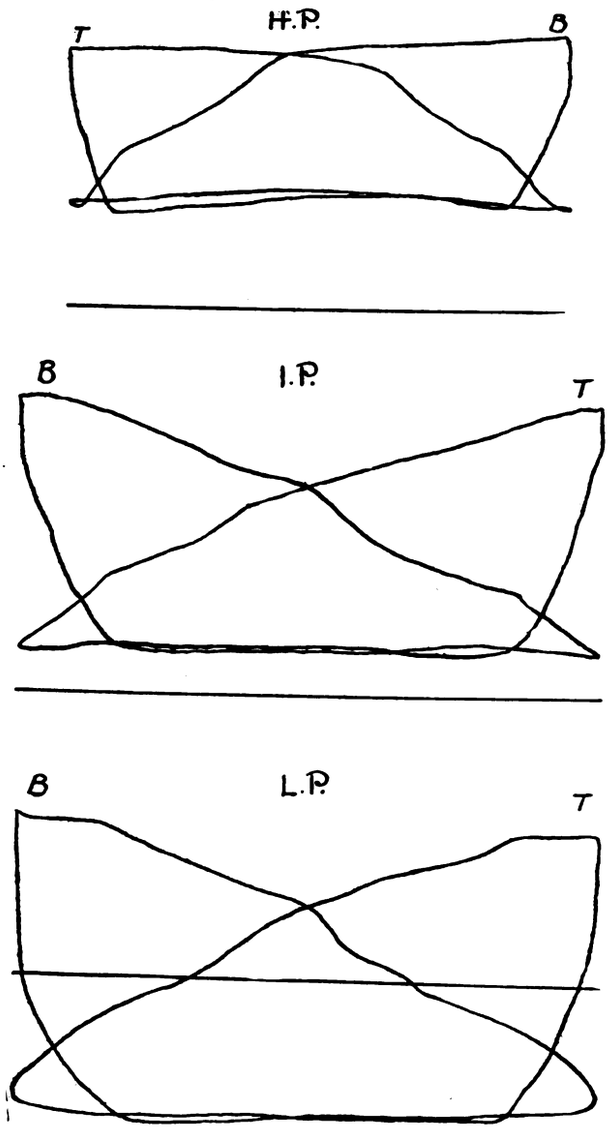
Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department—Indicator Cards from Marine Engines will be Analyzed and the Horsepower Calculated, Provided Complete Data Are Sent with the Cards

CONDUCTED BY H. A. EVERETT*

Q.—Enclosed is a set of indicator cards from a triple-expansion engine. I want to know what power the engine is developing and what defects the cards show? S. M. C.

A.—The calculation for power is tabulated below. In general the cards are not bad, but the distribution of power should be improved. The high-pressure is under-



Indicator Cards from Triple Expansion Engine (Not Full Size)

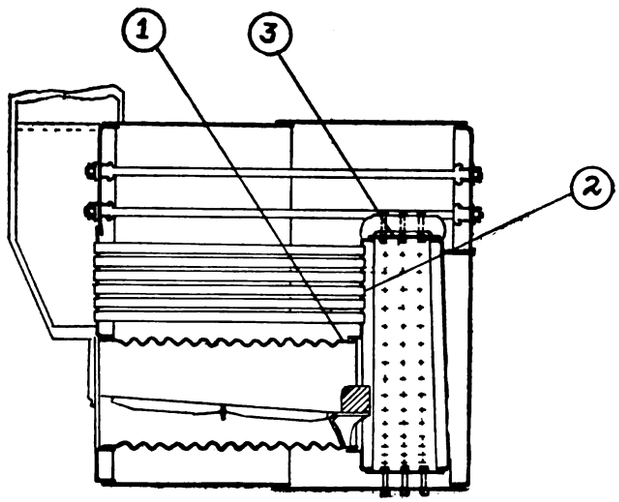
powered, and since release in this cylinder occurs too early, as evidenced by the loops in the toes of the cards, its power would be increased by working the high-pressure gag so as to delay cutoff a trifle more. As cutoff is early in the intermediate, it would be well to link up the whole engine a bit before working the gags. A good scheme is to take cards and without removing them from the indicator drums, take other cards superposed on them after changes of this sort have been made, so that the effect can be traced. *Change only one thing at a time.* The curved exhaust line of the high-pressure card indicates either leakage through the valves or restricted receiver space.

		Area Sq. In.	Length Inches.	Spring Lbs. Per In.	M. E. P.	Area of Piston Sq. In.	I. H. P.	I. H. P. Per Cyl.	I. H. P. Total.
A H. P.	TOP	2.25	3.19	100	70 5	415.5	242		
A H. P.	BOT	2.24	3.19	100	70.3	395.9*	230	472	
A I. P.	TOP	3.24	3.74	40	34.6	1075.2	308		
A I. P.	BOT	3.14	3.74	40	33.6	1055.6*	294	602	
A L. P.	TOP	4.18	3.71	10	11.3	3019.1	282		
A L. P.	BOT.	4.20	3.71	10	11.3	2999.5*	280	562	1636

*5-inch piston rod assumed.

Q.—What parts of a Scotch boiler should be examined first for deterioration, and what kind of defects should be looked for? T. JONES.

A.—The following tabulation gives a list of the commonly inspected portions of Scotch boilers with the character of defects frequently found at these places. Leaving out of consideration deterioration by pitting and scale which may be erratic, one would expect the normal deterioration of a boiler to first show up in the three places first mentioned in the table.



Parts of Boiler Where Deterioration Occurs

PART	DETERIORATION COMMONLY FOUND.
Top of furnace where it joins combustion chamber (1) in figure.	Burning away, cracks, scale, grooving.
Back ends of tubes (2) in figure.	Burning away.
Top of combustion chamber under girder stays (3) in figure.	Burning away; fractured stays; deformation.
Back of combustion chamber.	Scale.
Furnaces (general).	Scale on crown. Pitting and longitudinal cracks along line of fire bars. Transverse cracks along corrugations; distortion.
Tubes (general).	Pitting, cracks, scale.
Joints and seams.	Leakage.
Front connection.	Distortion.

*Assistant Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Boston, Mass.

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Q.—If I know the steam pressure carried and the amount of coal burned per hour in the boilers of a ship, how can I calculate the size of the steam mains? ENGINEER.

A.—The size of the steam main is a function of the speed at which it is allowable to have steam pass through the pipes. Good marine practice permits a speed in the main steam pipe of about 8,000 feet per minute. The volume of the high-pressor cylinder at cutoff multiplied by twice the revolutions per minute will give the total amount of steam passing through the main steam pipe. Dividing this by 8,000 gives the area which the steam pipe should have; commonly the entire volume of the high-pressure cylinder instead of volume up to cutoff is used. For example, an engine with a 25-inch high-pressure cylinder by 48-inch stroke at 75 revolutions per minute will require a main steam pipe with an area of

$$\frac{3.4 \times 4 \times 2 \times 75}{8{,}000} = .256 \text{ square feet}$$

Diameter = 6⅞ inches.

Q.—What method should be used for determining the size of a feed pump required to feed boilers of a given size? L. P .S.

A.—Lloyd's Rules require that ships are to be fitted with two feed pumps, each capable of supplying the boilers; and a conservative working rule is to make each pump of such size that its rated capacity when working at the upper range of its speed shall be twice the normal evaporation of the boilers.

Q.—Assuming two boilers of the same dimension with an equal grate area, one carrying 100 pounds and the other 160 pounds pressure, which would require a larger safety valve, and why? L. P. SHONTS.

A.—The General Rules and Regulations of the Board of Supervising Inspectors of the United States give the following formula for the required area of all safety valves:

$$\text{Formula: } a = .2074 \times \frac{W}{P}$$

where a = area of safety valve in square inches per square foot of grate surface; W = pounds of water evaporated per square foot of grate surface per hour; and P = absolute pressure per square inch = working gage pressure + 15, so that assuming boilers of equal grate area and equal evaporation per square foot of grate surface per hour, the boiler carrying steam at 100 pounds pressure would require a larger safety valve than the one carrying steam at 160 pounds pressure. The reason is that the specific volume of steam at 100 pounds is greater than at 160 pounds in the approximate ratio of $\frac{160}{100} = 1.6$, so that to blow off the *same amount of steam* with the *same allowable velocity* through the valve, we should need an area greater by this proportion for the boiler carrying steam at 100 pounds.

Q.—I have two Scotch boilers, 11 feet long, 12 feet diameter, with three furnaces in each boiler, 8 feet long by 38 inches diameter. The length of the grate is 6 feet. What drop should be given the grate bars and would it be wise to lower the front end of the grate bars also? A. A. McM.

A.—The slope of the grate bars should be about ¾ inch to 1 inch per foot. If the grate is over 5 feet long there is generally some difficulty in stoking the back end of the fire. The slope helps to overcome this trouble and, at the same time, the fire is better supplied with air at the back, and is not choked by the products of combustion from the front.

The area over the fire-bridge at the back end of the grate should be about one-sixth of the grate area, and the height from the bridge to the top of the furnace about 40 to 45 percent of the furnace diameter. The fire-bridge is generally about 5 inches to 8 inches above the level of the grate at the back end.

For a furnace 38 inches in diameter having a grate 6 feet long, the above rules would place the top of the fire-bridge about 3 inches above the centerline of the furnace, the grate bars at the back end would be about 4 inches below the centerline, and a slope of ¾-inch per foot would place the front end of the bars about ½ inch above the centerline.

Q.—What is the difference between tonnage and displacement? M. O.

A.—*Tonnage* is intended to serve as a measurement of the internal capacity of the vessel, and for this purpose the arbitrary unit of 100 cubic feet is adopted as equal to one ton. A ton in this sense means nothing other than 100 cubic feet of interior space.

Displacement is the volume of water which the ship displaces when floating and the weight of the displaced water is equal to the weight of the ship. Thirty-five cubic feet of sea water weigh one ton, so that a ton for displacement calculations is thirty-five cubic feet.

Freight Handling Appliances at Marine Terminals*

Within the past two years the problem of package freight handling by mechanical means has received the attention of railroad and steamship companies, the manufacturers of mechanical handling appliances and public boards interested in terminal construction. Development has been principally along two lines, the overhead and the surface system, though a third, the conveyor system, has received some consideration. The conveyor system, while perhaps well adapted to certain special conditions, is believed to be not sufficiently flexible to meet the complex requirements of a typical marine and railway terminal.

STORAGE BATTERY TRUCK

The storage battery truck has been introduced and has found favor in several terminals. It takes the place of the old hand truck, making it possible for a man to travel faster and with a much heavier load, hence reducing the cost of transportation but not otherwise affecting the problem of hand labor. This truck has the advantage of easy introduction into old terminals, requiring only a reasonably smooth floor. Like the hand truck, it can enter box cars and ships having side hatches.

In this connection may be mentioned the inclined elevator which has been introduced at a few marine terminals for carrying loaded trucks up a steep grade. The storage battery truck carrying a light crane has also been introduced, but up to the present time has not found a broad field of usefulness.

OVERHEAD MONORAIL SYSTEM

The overhead monorail system is being pushed by several manufacturers and is looked upon favorably by many interested in terminal development. It is not a new device, but is rather the application of an old device to a new field, for it has long been used to a limited extent in industrial plants. Its introduction into the field of freight handling has resulted in some interesting improvements, especially in track and track switch systems.

Ingenious devices have been worked out for throwing the switch to the desired position and automatically plac-

* Extract from report on Hoisting and Conveying, presented at the annual meeting of the American Society of Mechanical Engineers, New York, December, 1913.

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ing a stop at the open track end by the approaching trolley. One system lately introduced avoids the use of any moving part in the switch steering mechanism carried by the trolley, enabling the operator to take any desired course through the switch without stopping.

An overhead system which has been used to some extent in Europe and which has its advocates in this country employs what is termed the gliding switch. It has a curved switch member which slides along the main track. It permits a trolley to pass from the main track to the traveling cross track at any position. This switch is, as far as the main track is concerned, a derailing device. It is believed by the Committee that no installation of this type has been made on this side of the Atlantic.

Several installations of monorail systems for handling package freight have been made in this country, one at the Baltic terminal, New York, in 1912, which handles freight both ways between vessels, warehouse, and a freight shed alongside a railway track. The system passes over streets and tracks at a suitable elevation so as not to hinder in any way the traffic on the ground level.

Advantages and Limitations

In the present development stage, the storage battery truck and the monorail overhead system appear to be competitors for the field. Certain advantages and limitations of each are recognized. The battery truck as mentioned above will enter box cars and side ports of ships. It will go anywhere a smooth floor is provided, but it will only transport and will not hoist.

The overhead system involves greater initial cost. The trolley will go only where track is provided and will not enter box cars, but it will serve flat cars and may reach out over a ship, serving any hatch or the dock without regard to level as affected by stage of tide. It will hoist as well as transport, thus providing a means of transferring freight from one floor to another, and with the traveling cross track will serve areas and tier freight. The monorail trolley affords higher speed of travel than the battery truck. As it does not require clear floor space for a roadway, more floor is available for checking, storage, etc., and the capacity of the terminal materially increased. This increase in capacity should in a great measure, and perhaps fully, justify the greater outlay. It is probably a safe prediction that the two systems, the overhead and the surface, will supplement each other, though different local conditions may sometimes control.

Co-operation between railroads, steamship and dock companies, and machinery manufacturers is absolutely essential to the best results in the development of devices for the mechanical handling of freight. Modifications and improvements in the organization and management of terminals must of necessity be made coincident with the installation of the hoisting and conveying appliances in order that such machinery may best serve its purpose.

In the past year the mechanical handling of lumber has received considerable attention. This is particularly true on the Pacific coast, where extensive preparations are being made for handling the large increase in business that is predicted will result from the opening of the Panama Canal.

Handling Lumber

The unit system of handling lumber is becoming more and more general. By the unit system is meant the sorting and stacking of lumber in uniform units which may be separated by skids or chocks, and one unit or package handled at a time. Modern hoisting and conveying appliances are equipped with automatic grapples so that these units may be picked up or deposited by the operator in the hoist. The units will range from 3 to 8 tons.

In this work the monorail man trolley has been a recent and important development. The locomotive crane has also found a field in this branch of industry and in some cases the locomotive crane of the portal pier type is needed, so that freight cars may pass between the legs of the cranes and be loaded and unloaded by it. This type of crane is designed to travel along the face of the dock for handling lumber directly to and from boats, and by means of a transfer table the crane may be switched to branch tracks for the handling of lumber to and from storage piles.

Probably the most radical development in the lumber handling industry is that which the C. A. Smith Lumber Company, of California, have undertaken. The unit system is employed and the lumber is handled by various types of cranes. Cantilever cranes are used on the dock face for loading specially constructed vessels for the trade, which enable the large 8-ton units of lumber to be stowed intact. This means of direct handling of large units, and the development of special vessels to facilitate handling most nearly approach the history of the development of the coal and ore handling business on the Great Lakes.

Transshipment at Sea

Two novel forms of cableways have reached their perfected stage during the year 1913. Both of these are for use on the high seas, one for transshipping coal, ammunition and supplies to warships in mid-ocean under headway, and the second for transshipping persons from a wreck to a life-saving ship.

The apparatus for coaling at sea has been under development for over ten years, but not until the last year, and since the newly developed automatic tension engine has been added, can the marine cableway for coaling at sea be regarded as a complete solution of the problem. During recent tests at sea a collier, while rolling 20 degrees in a driving storm, transshipped 83 tons of coal in an hour to a battleship 400 feet astern of the collier while both were proceeding at a speed of about 7 knots.

The life-saving machine comprises the old-fashioned breeches buoy apparatus, in common usage along the coast, in connection with a small-sized automatic tension engine serving to wind in and pay out the main supporting cable or hawser serving as a trackway for the passage of the breeches buoy from ship to ship.

Opening of the Panama Canal

With little ceremony the Panama Canal was officially opened for the traffic of the world on August 15 by passage of the United States War Department steamship *Ancon* from deep water on the Atlantic side to deep water on the Pacific side. The vessel which has been leased to the Panama Railroad for service between New York and Colon, left Cristobal at 7 o'clock in the morning with many notable people on board, including officials of the Canal Zone, and arrived at Balboa, at the Pacific end, at 4 o'clock in the afternoon, making the passage in nine hours. The passage through the Gatun locks, which have a lift of 85 feet, was made in seventy minutes. The ship had a full cargo on board, so that the passage could be made with a ship at full load draft. Earlier in the month an experimental voyage through the canal was made by the steamship *Christobal*, of the Panama Railroad & Steamship Company, the passage from the Atlantic to the Pacific being made in 11½ hours and the return trip in 8½ hours.

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Letters from Practical Marine Engineers

A Department for the Readers' Discussion of Ideas Relating to the Design and Handling of Marine Engines, Boilers and Auxiliaries, Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

A New Trick in "Trick" Valves

The compound engines of a tug had undergone certain repairs, one of which was the fitting of a cast iron liner in the high-pressure cylinder, so that, with the same propeller the power delivered would be less according to the heating surface of the boiler, which had been too small as first designed. A new high-pressure slide valve was fitted, and, in order to reduce the wear and tear and thus decrease the driving power required by it, an arrangement as shown in Fig. 1 was used. The relief frame over the valve had ports cut in it corresponding with the ports to the cylinder, and two holes were formed through the steam passage, as shown, to allow steam on both sides of the valve and thus balance it. For the greatest part of travel this allowed only exhaust steam, however, to the back of the valve to balance the initial pressure on the face of the valve.

Even on the first trip with this arrangement the coal consumption was noticeably increasing, which it continued to do for six months. During this time the engineers had tried several remedies, such as altering lead, cut off, release and compression. The writer was then consulted and immediately decided that the relief arrangement did not relieve the valve, and promptly designed a new valve, as shown in Fig. 2.

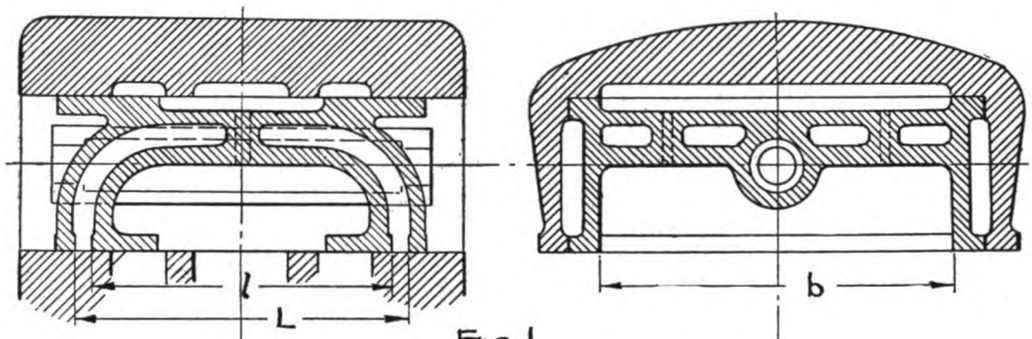

FIG. 1

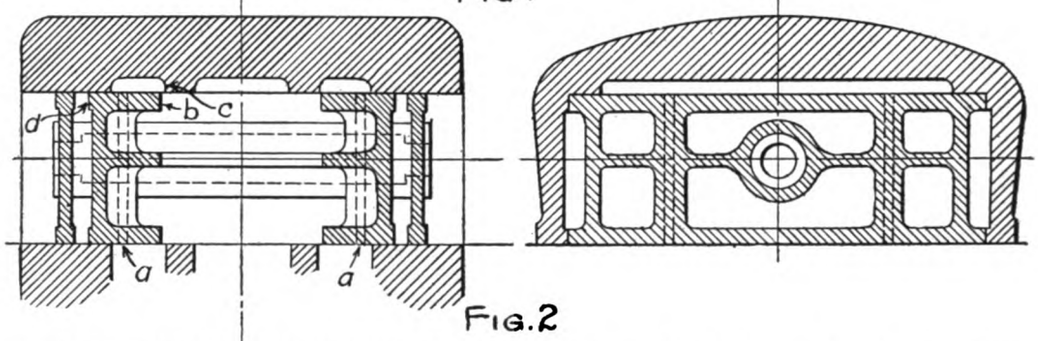

FIG. 2

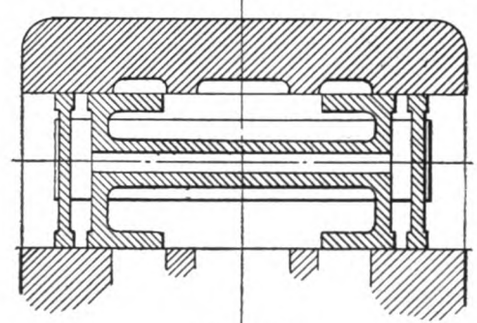

FIG. 3

In Fig. 1 it can be seen that the upward pressure which should be overcome is the initial pressure of the steam $\times (L - l) \times b$. The new valve allows steam to enter both edges and by means of the small holes, *a*, keeps the whole perfectly balanced in all positions. The small holes, *a*, give communication for balance after *b* passes *c* and until *d* gives communication.

The new valve had the desired effect of decreasing coal consumption, which after half a year had increased to about 20 percent more than with the old valve. The leaking and water consumption had also increased until the feed pump, which had never given trouble, could not deliver sufficient water to the boiler. With the valve in Fig. 2, however, these troubles were eliminated.

In concluding, the writer would suggest that in designing a trick valve with a relief frame the designer use some arrangement similar to Fig. 3, in which the opening and closing of the admitting edge will be at four different points at the same time, and the whole valve will be relieved from pressure in every position. This was not used in the above case, as the clearance necessary was too great.

D. K.

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Poorly Designed Eccentrics

During the maiden voyage of the new steamer "F" between London and Tokio serious trouble was experienced because of a poorly designed eccentric sheave. The low-pressure ahead eccentric strap became hot, but as the rise in temperature was not serious and as the same thing had happened on the trial trip, there was not much anxiety felt by the engineer. This was only a few days out from London, however, and when the Mediterranean was reached the temperature became so high that relining of

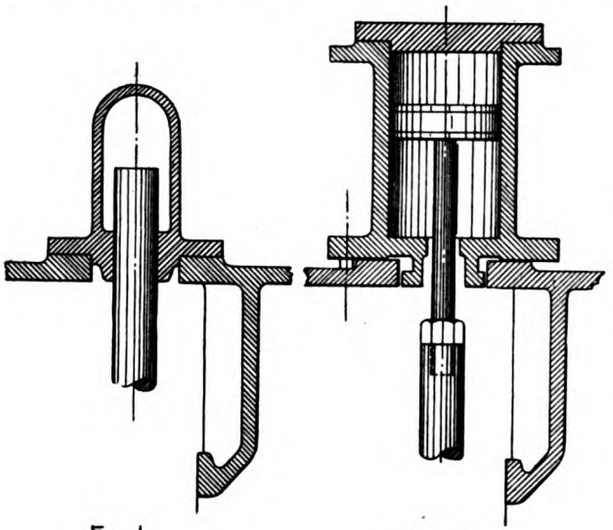

FIG. 1

FIG. 2

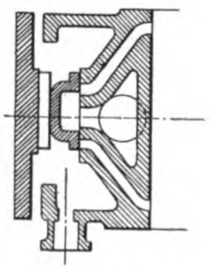

FIG. 3

the strap was necessary. The new white metal acted in the same manner and lasted only a very short time. It was then quite evident that in designing the strap it had not been made wide enough to account for the friction caused by valve friction, weight of valve, rods and link and the forces brought into play by the motion of the whole, particularly the acceleration forces and weights.

In order to take care of these forces, then, a balance cylinder would have to be used, but to make such a thing at sea would have been impossible. The first engineer, however, conceived of the idea which finally accomplished the required results.

He took a steam cylinder from one of the winches and by proper fittings and adjustments used it on top of the valve chest as a balance cylinder. The valve rod as designed projected through the chest and was guided in a brass bush as shown in Fig. 1. This bush was taken away and the studs by which it was connected to the chest were cut off and riveted over so that the flange would present a flat surface. The end of the valve rod was cut off to shorten it the required amount, so that when set up as in Fig. 2 the piston would not touch the cylinder head when the valve is at the top of its travel. A hole was then bored in the end of the rod and tapped to take the end of the piston rod of the winch cylinder, which was screwed in and fastened with a checknut, as shown in Fig. 2. New holes were bored in the flange of the valve chest to correspond to the holes in the winch cylinder flange and studs were fitted to join the two. The neck bush and gland were taken from the winch cylinder stuffing box and the whole arrangement set up and packed. The steam in the low-pressure valve chest had free access to the underside of the piston in the improvised balance cylinder, and by setting the steam valve in the winch cylinder, as indicated in Fig. 3, any steam that found its way to the upper side of the piston was led off to the exhaust and out by means of a one-inch copper pipe which led the steam to the condenser.

The engine was started after everything was assembled as outlined, and it remained running while the ship was moored for a day, until it was concluded that the improvised cylinder had the desired effect. The journey was then continued and no further trouble was experienced. In Tokio the winch cylinder was taken off and reassembled as a winch to be used in loading and unloading, after which it was again used as a balance cylinder, and acted very ably in that capacity for the remainder of the voyage. Upon arriving at London a new balance cylinder, well designed for the purpose, was installed and the winch cylinder returned to its proper place. ENGINEER.

A Leaky Cylinder

The compound engine of a certain steamer had been converted into a triple expansion engine by introducing an intermediate cylinder. It was necessary to bush the high-pressure cylinder to decrease its diameter. This was done by inserting a close-fitting bushing and reboring so that a liner one inch thick was left in the cylinder. This

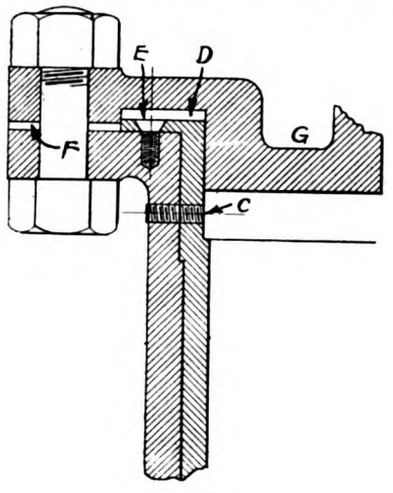

Fig. 1

bushing was flanged at the top and secured by flush dowels at *C*, Fig. 1, and at similar points around the bottom of the cylinder. It will be noticed that the cylinder head *G* was also turned down to fit into the new counterbore.

This arrangement was quite satisfactory until the vessel started out on a certain trip with a first assistant engineer who knew nothing about that bushing. The writer, who was chief engineer at the time, had seen the bushing fitted and knew that the only proper way to pack the cylinder head was at *D* rather than at *F* only.

The vessel had just left New York and had dropped her pilot when the high-pressure cylinder began to wheeze

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and whistle, then leak like a sieve through the cylinder head joint, while the engine slowed down considerably. The chief engineer announced to the captain that it would be necessary to drop anchor immediately and the engines shut down. The chief then examined the joint and found that it had been packed at *F* only by the first assistant just before leaving port. Further examination showed that the studs or dowels had broken and allowed the bushing to twist around and partially cover the ports in the cylinder wall. This undoubtedly had more to do with the engine slowing down than anything else. The leaking through the joint was caused by the bushing riding up at *D*, where there was about ⅞-inch clearance.

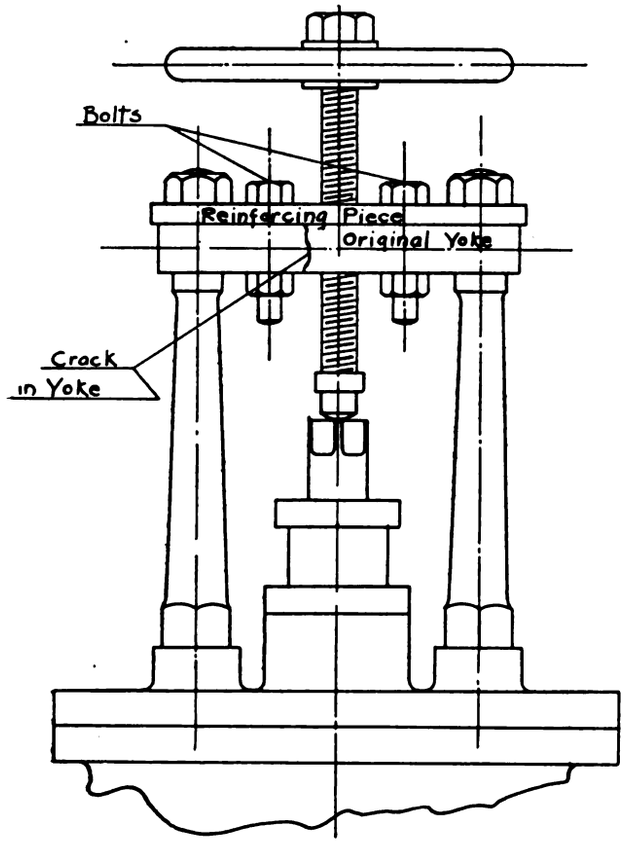
The head was taken off and by using a dolly bar, which had to be bent for the purpose, the bushing was turned back to its original position so that the ports would coincide. It was then rammed down and new holes drilled and tapped in the flange to take the studs *E*. These holes were countersunk and the studs cut off and riveted over to fill the countersink and present a flush surface. The joint was then packed at *D* and the cover replaced and brought down tight. This arrangement worked very well —in fact, it caused no more trouble or anxiety.

If the joint had been packed at *D* as in the usual way there would probably have been no trouble, because when examining the bushing and dowels the writer found that the latter had been broken for some time, and concluded that the packing alone when at *D* had been sufficient to hold the bushing in place. "MAC."

Repairing a Yoke on Throttle Valve

On vessels having no steam traps or drainers attached to the steam pipe water of condensation will cause trouble and usually shows its presence by what is called water hammer. The writer recalls an experience on board a tugboat which had docked overnight with a single crew sleeping aboard. The steam pipe was lower than the water and the drip led to the ash pan. This the fireman closed at night because the steam bothered him, and in the morning he closed the furnace doors before draining the steam pipe. It soon began to hammer and awakened the engineer, who rushed in and closed the stop valve on the boiler. About the time the stop valve was closed the yoke on the throttle valve broke. This had to be repaired immediately, as the boat was to run that day. Fortunately there was about three-quarter inch of thread above the nuts on the standards and a flat piece of iron was found in the junk box sufficiently long to span the yoke and about 3 inches by ⅝ inch, the crosspiece itself being of brass, 3 inches by 2 inches, in section. A hole was drilled in the center of the iron piece a little larger than the stem and two holes about ½ inch in diameter drilled through the iron and brass pieces to match up so that they could be bolted together. Two more holes were then drilled to allow the standards to pass through and the whole placed on them, forming a new yoke. As will be seen, there was just enough thread on the standards to take a full nut. This was a substantial yoke and served as such for about four months, when a new butterfly throttle valve was installed. C.

Albany, N. Y.



Broken Throttle Valve Yoke

Engine Room Bulkheads

Some time ago it was my privilege to be in the engine room of a cargo boat on her trial trip. She was a very fine single screw ship and was supposed to be modern in every detail. Her engines were quadruple expansion and steam was supplied by Scotch boilers with a working pressure of 200 pounds per square inch working under forced draft.

After getting on board we had a general inspection trip. The engines were a very good job and the arrangement of the engine compartment was also good, giving a clean, simple appearance instead of the jumbled thrown-together type of arrangement too often found on cargo vessels. After a thorough inspection of the machinery and after complimentary remarks had been passed to the builders' representative, the engines were turned over and everything prepared for a very successful trial.

In half an hour we were on our way to the measured mile course under natural draft and easy pressure. Upon nearing the buoy, the blowers were started and the boilers fired up. Upon notifying the bridge that all was in readiness, we received orders saying that the trial was on. After running for a while under maximum conditions, we all noticed that the engine room began getting dusty. Ash dust seemed to come from somewhere in large quantities. Of course, dust was very bad for everything and everybody concerned, so an investigation was started. The door between engine room and boiler room was found securely shut, but upon further search it was revealed that the dust was coming through the bulkhead between the engine room and boiler room around the steam pipes. It seems the builders of the vessel had cut large holes in this bulkhead to facilitate the pipe fitting, but had neglected to take any steps to close up the openings after the pipes were in place. In fact, in one case the lead of the pipes had been changed and the old opening in the bulkhead was left untouched, which now formed a good ash dust ejector into the engine compartment.

The conditions soon got so severe in the engine room that it was decided to abandon further trials in order to avoid hot bearings and other damages to the main en-

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gines. Ash dust, as is well known to all marine engineers, will get into any bearings and on guide surfaces, and nothing is worse for heating them up, especially on a new job where things are liable to overheat, anyway.

Upon return to the shipyard the engines had to be carefully look over and all bearings everywhere opened up. Since the bulkhead between engine room and boiler room was not a watertight one, it was a simple matter to close up the openings and arrange it dustproof. This was done by bolting circular plates in two pieces to the bulkhead around the pipes and letting the plates bear slightly on the lagged pipes with a piece of canvas between to take care of the irregularities of the lagging and assure a fairly tight job.

All this delay and extra work was caused by carelessness in the first place. The builders should have known the need of a good bulkhead and the owners' representative should have seen that a good one was built. This occurred when all the yards were very busy and behind time in their deliveries, and faults of this kind with their little delays cost both owner and builder a lot of money which could so easily be avoided. STRUCTURE.

Flow of Air Through an Aperture

In the July issue of INTERNATIONAL MARINE ENGINEERING, in an article on "The Rational Non-Diesel Marine Oil Engine," Mr. Albert H. Ziegler makes a statement regarding the flow of air through an aperture which the author cannot very well sustain either practically or theoretically. Mr. Ziegler states: "The velocity of gas through an aperture is dependent upon the ratio of the pressures on both sides of that aperture, whether the pressures involved be high or low."

There follows an example for the purpose of making the matter clear, as follows: "The velocity would be as high through an aperture with a pressure of 2 pounds absolute on one side and a pressure of one pound absolute on the other side as the velocity caused with a pressure of 1,000 pounds absolute on one side and 500 pounds absolute on the other side." Now if this statement were correct, the velocity of a gas through an aperture would vary directly as the pressure; in other words, if we had a pressure of 2 pounds on one side and 1 pound on the other side, our ratio would be two to one, and if we had a pressure of 1,000 pounds on one side and one pound on the other side, our ratio would one thousand to one, and, according to Mr. Ziegler's law, "the velocity varies as the ratio of the pressures," we would in the second case have a velocity 500 times as great as that in the first case.

Now, according to the laws of nature, the velocity of gases passing through an orifice follows the same law as that governing the velocity of falling bodies, disregarding friction, of course, and this law states that the velocity of falling bodies varies as the square root of the height of the fall.

In Mr. Ziegler's example, we have a difference in pressures of one pound in one case and 500 pounds in the other case, both pressures producing the same velocity. Of course, it is understood that with the higher pressures the density of the air is so much greater that its velocity is bound to be impeded, but surely not to such an extent.

The statement regarding the atomizing of the fuel charge is incorrect, as the pressure of the atmosphere due to a partial vacuum in the cylinder is not sufficient for the heavy fuel oils. This I have found to be so in experimenting with the Secor oil engines in which the oil is atomized by "suction." I am using this term with apologies. The Secor engines operate very nicely on kerosene (paraffine) oil, but with the heavier grades of fuel oil there is trouble, as the velocity of the atomizing air is not sufficient to break up the fuel into a spray sufficiently fine to form a perfect mixture. In an earlier paragraph of Mr. Ziegler's article he states that the first and last drops of a full charge always reach the cylinder of the engine in a liquid state, but this is true only with the common atomizers now in use. That it is possible to atomize the full fuel charge I have already demonstrated with an engine of my own design, in which I am using the 5-degree Baume Texas fuel oil with absolutely no formation of carbon deposit in the combustion chamber, and with a colorless exhaust. This engine is a radical departure from the Diesel as well as from the hot ball types of engines, and develops a horsepower on .5 pound of the above-named fuel per hour.

The pressure of the atomizing air in this engine is about 40 pounds per square inch (55 pounds absolute), and this pressure I have found to be the most satisfactory, as the best results are obtained with the least amount of power required for compressing the air. The design of the engine is such that the air is used immediately upon compressing; thus the heat of compression is maintained, preventing the frigerative effect of the expanding air upon the oil.

The tendency among oil engine designers is to use as little air as possible for atomizing the fuel. In the Diesel engine it would be out of the question to use a large volume of air for this purpose, as with such high pressures the power consumed by the compressor would be too large a factor, but with a pressure of only 40 pounds we can afford to be more liberal with our air supply as long as we can offset the extra power required for compression by greater fuel efficiency. H. E. A. RAABE.

Jersey City, N. J.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

BATTLESHIPS

	Tons.	Knots.		May 1.	Aug. 1.
Nevada	28,000	20½	Fore River Shipbuilding Co..	63.9	72.4
Oklahoma ...	28,000	20½	New York Shipbuilding Co..	67.2	72.6
Pennsylvania.	31,400	21	Newport News Shipbuilding..	29.1	42.0
Arizona	31,400	21	Navy Yard, New York.....	11.5	24.4

TORPEDO BOAT DESTROYERS

Downes	1,010	29	New York Shipbuilding Co..	95.3	95.3
O'Brien	1,050	29	Wm. Cramp & Sons.....	62.2	79.0
Nicholson ..	1,050	29	Wm. Cramp & Sons.....	60.5	73.3
Winslow	1,050	29	Wm. Cramp & Sons.....	54.4	71.5
McDougal ..	1,050	29	Bath Iron Works.....	89.3	100.0
Cushing	1,050	29	Fore River Shipbuilding Co..	41.5	56.1
Eriesson	1,050	29	New York Shipbuilding Co..	61.6	76.9
Tucker	1,090	29½	Fore River Shipbuilding Co..	9.4	12.6
Conyngham..	1,090	29½	Wm. Cramp & Sons.....	6.8	11.1
Porter	1,090	29½	Wm. Cramp & Sons.....	6.7	9.0
Wadsworth..	1,090	29½	Bath Iron Works.....	17.5	48.4
Jacob Jones..	1,090	29½	New York Shipbuilding Co..	9.8	14.9
Wainwright..	1,090	29½	New York Shipbuilding Co..	9.8	14.4

SUBMARINE TORPEDO BOATS

G-4	....	....	Wm. Cramp & Sons.....	96.4	96.4
G-2	....	....	Newport News Shipb'g Co...	89.7	89.7
G-3	....	....	Lake T. B. Co.....	81.6	82.3
K-3	....	....	Union Iron Works.....	94.0	98.1
K-4	....	....	Seattle Con. & D. D. Co.....	93.9	98.8
K-5	....	....	Fore River Shipbuilding Co..	92.8	98.8
K-6	....	....	Fore River Shipbuilding Co..	92.8	98.8
K-7	....	....	Union Iron Works.....	88.9	94.3
K-8	....	....	Union Iron Works.....	88.4	94.3
L-1	....	....	Fore River Shipbuilding Co..	30.3	49.3
L-2	....	....	Fore River Shipbuilding Co..	30.3	48.2
L-3	....	....	Fore River Shipbuilding Co..	30.3	47.3
L-4	....	....	Fore River Shipbuilding Co..	30.2	46.6
L-5	....	....	Lake T. B. Co.....	8.1	28.9
L-6	....	....	Lake T. B. Co. (Long Beach, Cal.)	0.0	28.1
L-7	....	....	Lake T. B. Co. (Long Beach, Cal.)	0.0	26.6
M-1	....	....	Fore River Shipbuilding Co..	20.8	33.1
L-8	....	....	Navy Yard, P'tsmouth, N. H.	0.0	0.0
L-9	....	....	Fore River Shipbuilding Co..	1.9	12.3
L-10	....	....	Fore River Shipbuilding Co..	1.9	12.3

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Marine Articles in the Engineering Press

Discussion of Feed-Water Heating, Oil Burning and Economy of Steam Power Plants—New Methods of Propulsion—Harbor and Canal Improvements

Marine Feed-Water Heating.—By Lieutenant Commander H. C. Dinger, U. S. N. In presenting the general methods of reducing steam consumption in marine engineering, and particularly the use of feed-water heating as applied for that purpose, the author of this article shows a clear conception not only of the theoretical side of the question, but of the practical one also. Economy finally resolves itself into the question of conserving the heat units, making it a thermodynamic problem so that success can only be obtained by properly following out thermodynamic principles. The questions of vacuum, superheat, and feed-water heating are almost utterly neglected in marine practice, and the author explains that it is probably due to the first cost being considered too much. Important note is made of the fact that different designs of engines vary the economy, but the possibilities to be gained by the use of superheat, high vacuum and the highest feed temperatures are greater than changes in design are likely to produce for several years to come. The subject of feed heating is discussed in detail and includes the general principles underlying the subject for naval and marine work and deals largely with the practical points of the construction, etc., of the various types of feed heaters. Two tables are included for practical use, one giving the percentage of saving in fuel by heating the feed water with exhaust steam assuming 100 pounds boiler pressure, the other giving the percentage of saving for each degree of increase in temperature of feed water heated by waste steam. In connection with these tables general data are presented in such a clear, concise manner that it is convincing enough to eliminate all argument against using a system for feed heating. The general types of feed heaters are described and discussed with regard to relative merits and advantages under different conditions for adaptability. To carry out the practical description, together with constructive details, such subjects as piping of heaters, steam piping connections, position of steam and water connections, baffling, kind of tubes and fittings are discussed. Practical information is given for the heating surface required, including data for the same on such types as Normand or Wainwright plain-tube heaters, Reilly heaters, Wainwright corrugated tube heaters and Schutte and Koerting film heaters. A discussion of the sizes of tubes used in heaters shows how these may effect efficiency, weight and cost. Descriptions of the flow of steam and water through heaters, operation of heaters, saving due to heaters, installation, series heaters, special types of heaters and the effect of condenser arrangements and operation on feed heating are given in such detail as to make the information extremely valuable, especially in deciding which type would be applicable under the various conditions of operation. The comments made upon the design, construction and operation of the various types are based on the results of actual experience in operation, therefore the information is quite unbiased and reliable. 17 illustrations. 14,000 words.—*Journal of the American Society of Naval Engineers,* February.

Oil Burning.—By Lieutenant Commander John J. Hyland, U. S. N. The subject of fuel oils, their composition, general characteristics, and their utilization in oil-burning boilers, with a description of the apparatus employed and the means used to properly burn them, is treated very thoroughly in this article, and the author has included extensive data, mostly in the form of statistics regarding the yield and various characteristics of the oils. Fuel oil is classed as topped crude oil or petroleum—i. e., crude oil with its lighter, more valuable and dangerous constituents removed by distillation. Petroleum or crude oil is divided into three classes, and according to Dr. David T. Day, of the U. S. Geological Survey, these may be traced to one complex mother oil of the asphaltic type. Dr. Day further states that the yield of the United States in crude petroleum is 220,000,000 barrels, and gives a table showing their division by distillation or fractionation. Following this are tables showing the world's production of petroleum in barrels for the years 1907 to 1911, inclusive, the various chemical constituents and characteristics of the various fuel oils. Before an oil is burned certain tests should be made to determine its characteristics. These tests are enumerated and the author has described each one in detail, giving methods and formulæ where needed. It was found that in order to have an explosive mixture 1 percent to 1.5 percent of vapor is needed, and a table is given, including data obtained with different kinds of oil, showing temperature to which oil was heated, oxygen percent, vapor percent and flash points. Turning to the subject of burning fuel oil in a boiler under mechanical or pressure systems of atomization, it is conveniently divided into three heads: the boiler furnace and its accessories; the oil-burning apparatus proper, consisting of burners, tuyeres, air cones or air registers; and air regulation, oil regulation and aids used to make the combustion as perfect as possible. Under these three heads the mechanical system of burning oil, the various apparatus used since its development, and the changes made therein since the mechanical system was introduced, are described in detail and the methods of burning oil with steam or air burners are described briefly. The proper stack or uptake area is discussed in connection with a table showing results obtained with a Yarrow boiler having a steam pressure of 240 pounds and 4,500 square feet of heating surface. Fire brick also forms an important part of the system in its function as a refractory lining for the furnace. The discussion of burners, the principles employed in their manufacture, and the various types used correct the idea of oil issuing from the burner tip of a mechanical form in a revolving spray and presents the reader with the fact that the oil issues in straight lines in a hollow conical spray of various angles up to 90 degrees. The various types of burners are described, such as the Schutte-Koerting, Thornycroft, Howden, Bureau Steam Engineering, Normand, Fore River and Peabody burners. Several curves are also given showing pounds of oil discharged per hour per burner plotted on the discharge pressure at burners in pounds gage. Another set of curves shows viscosities Engler compared with water at 70 degrees Fahrenheit equals unity plotted against temperature in degrees Fahrenheit. A set of curves for pumping capacities of Mexican oils shows the delivery in gallons per hour plotted on temperature in degrees Fahrenheit. There is also included a curve of very interesting character showing the temperature capacity of a Peabody mechanical burner. This

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curve gives the pounds of oil per hour per burner plotted against the temperature of oil in degrees Fahrenheit. The subject of air cones, air registers or tuyeres is then discussed and the various types described. The amount of air required for combustion forms a computation study and necessary formulæ are developed. Air chambers on fuel oil lines, aids to combustion and methods of running under an oil-fired boiler (including curves of data obtained under such conditions with Yarrow, Normand and Babcock & Wilcox boilers) conclude the article through mechanical burners. The subject of steam or air burners is divided into two general headings, their general classification and the various types used for both metallurgical work and boiler work. There are five general classes, besides the two main divisions of outside and inside mixing. These are drooling, atomizer, chamber, injector and projector burners. The various types described are the Peabody burner, W. N. Best high-pressure oil burner, Gem oil burner, Gilbert & Parker oil burner, Rockwell high-pressure, Hammel, Kirkwood, Lassoe, Ingram and Fitton oil burners. Two safety devices for oil are described, the Lalor valve and the Foster valve, both of which have the same essential principle. The author concludes with a general statement, pointing out that it is no easier to burn oil with the use of compressed air or steam than with the mechanical system. 56 illustrations. 10,200 words.—*Journal of the American Society of Naval Engineers*, May.

New Ship Propelling Methods.—An important feature of modern marine steam engineering is stated to be the installation of exhaust turbines in connection with reciprocating engines. The advantages of this arrangement, usually of one turbine to two reciprocating engines, are found to be on the average a full power steam economy of 25 percent over installations entirely of reciprocating engines and a saving of space over installations entirely of turbines. Data are given of the plants of the German steamer *Cap Trafalgar* and the British steamer *Britannic*. Modern Diesel engine plants are considered to be a little under a cloud at present, due to rather too highly pitched expectations of economy. Shipowners are disappointed partly on account of delayed deliveries, of unexpected breakdowns, partly on account of a rise in the price of fuel oil, of unexpectedly high consumption of lubricating oil and of a higher wage scale for engine room crews. All this in connection with high first cost and interest charges has dampened the enthusiasm for Diesel engine installations. A number of recent plants are described like the ones in the French sail ship *La France*, in the Italian three-mast schooner *Aosta*, in the German tanker *Wotan* and in the Danish freighter *Fionia*. While the first three installations have two-cycle engines, the last one has four-cycle engines, and the builders are said to have consistently stuck to this type. Of the *Wotan* installation a number of the difficulties experienced on the first voyage are given as observed and reported by an engineer of the builders. 22 illustrations. 3,370 words.—*Zeitschrift des Vereines Deutscher Ingenieure*, May 2.

Economical Performance of Various Recent Naval Vessels.—The data tabulated in this article were taken from trial performances of eight destroyers and two battleships and show the water and fuel consumption on different trials. All vessels included, except the *Henley*, were fitted with Parsons turbines. The *Henley* has Curtis turbines. It is noted that the water evaporated per pound of oil at full power, which averages about 12.5 pounds, is hardly a very creditable performance, but that on more recent destroyers these results have been considerably bettered. It is also noted that the boilers and oil-burning apparatus installed are capable of giving an evaporation of 14 pounds of water per pound of oil at full power when operated to the best advantage. For the destroyers the table of data includes total pounds of water per hour for all machinery, pounds of water for all machinery per hour per shaft horsepower of main engines, pounds of water evaporated per pound of oil (actual), pounds of oil per hour total per shaft horsepower of main engines, square feet of heating surface per shaft horsepower of main engines, knots per ton of oil, speed of vessel and slip of propellers in percent. The same relative data are tabulated for two battleships using coal instead of oil as in destroyers. The large steaming radius of the destroyers has been obtained by the adoption of cruising engines or cruising turbines. To approximate to the amount of water used for auxiliaries measurements were taken of all the water on one destroyer and only that used by the main engines on two others. These results, which show that the auxiliaries use from 13 percent of the total water at full speed to 26 percent at 12 knots, show that at all speeds more auxiliary exhaust is available than can be utilized in the feed-water heater. There is a close agreement of water consumption on the battleships with that on the destroyers, but the propeller efficiencies on the former are considerably better, making a materially better overall efficiency. Considering the engine and boiler-room weights only, the battleship weights will run 21 to 23 horsepower per ton, while the machinery weights on destroyers are about one-half per horsepower of what they are on battleships. 1,630 words.—*Journal of the American Society of Naval Engineers*, May.

Transmission of the Propulsive Power in Ships.—By Ernest N. Jason. A brief outline shows the three general successive steps in the transformation of the potential heat energy of the fuel into the mechanical energy in the form of rotary motion of the propeller as applied to the propulsion of ships. The first, that of transforming the potential heat energy of coal or oil into effective heat energy of water, steam or a fluid of gas mixture, is accomplished by such apparatus as boiler, producer or apparatus for the combustion of the fuel and the formation of a fluid possessed of the necessary energy. The second, that of transforming the effective heat energy into mechanical work and rotary motion, is accomplished in the steam engine, steam turbine or internal combustion engine, together with all necessary auxiliaries. The third, that of transmitting the motion of the prime mover to the propeller, is the question that forms a basis for the author's discussion. This transmission from the prime mover to the propeller is accomplished by direct coupling or by some system of indirect transmission, such as mechanical gearing, electrical transmission and hydraulic transformers. An illustration serves to show the importance in the question of transmission. The coal consumption of the U. S. S. *Delaware* is assumed brought down to that of the U. S. S. *Texas* for the same conditions, and using this as a basis figures are given to compare resultant and actual coal consumption for a day and for different cruising radii. Similarly a great saving is shown for a vessel of 72,000 horsepower in which the coal consumption is assumed cut from 1.45 to 1.3 pounds per horsepower, illustrating the need for "unrest" and the numerous designs for the best solution of the problem of transmission. A table giving the names and approximate horsepower of types and combinations of propelling machinery as extensively used in nearly all classes of ships, both of commercial and naval

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importance, gives a clear idea of the extent to which the various combinations for transmission have been applied in practice. The various combinations are again enumerated and their applications discussed, followed by a classification of the three general systems with their advantages and disadvantages. In order to have a clear idea of these as applied, the author describes the various systems in detail, giving necessary requirements, especially in that of mechanical gearing. The author has also included for comparison a table giving names of ships, year tried, system of power transmission, prime mover, maximum speed in knots, revolutions of propeller per minute, speed reduction ratio, total shaft horsepower and water consumption in pounds per shaft horsepower, together with remarks. Another table includes similar data, together with vacuum in inches of mercury, pounds of coal or oil per hour per horsepower, British thermal units per pound of coal or oil, thermal efficiency in percent of main engines, and British thermal units per minute used by whole machine installation per pound of indicated thrust. This table forms a resumé of the examples, which follow it, and serves to illustrate the economic value of several types of the most modern marine installations. 8,300 words.—*Journal of the American Society of Naval Engineers,* February.

The Development of Bremen in the Line of Harbor and River Construction Since 1880.—It is stated that to maintain the possibility of direct oversea traffic for the city of Bremen an extensive correction and dredging of the river Weser was required. Since 1884 this has been proceeded with after a systematic and carefully executed layout which established such depth of water that ships with 16 feet 5 inches draft could come up to the city of Bremen. It is shown that in the stream correction careful account had to be taken of the influence of the tide, amounting at Bremerhaven to about 12 feet, and of the volume of fresh water from the upper river, which led to the plan of contracting the river bed into a uniformly determined profile wherever it had been split or flattened out, or removing obstructions or excessive curvatures wherever they hindered the free flow of the water. To remove the amount of nearly 55,000,000 cubic yards that required dredging, the city of Bremen acquired three dredges and a large number of scows to the total value of over $1,500,000, which in 1895 completed the stream regulations. Since then, upon the establishment of 16 feet 5 inches draft limit, the adjoining villages and the city of Bremen have extended their docks and landings to a remarkable degree. For the future a deepening to 21 feet draft limit has been decided upon which it is expected will greatly enlarge the direct sea-borne traffic of the city. 5 plates. 61 illustrations. 8,000 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* June 6.

Intracoastal Waterways—The Cape Cod Canal.—By Lieutenant Commander A. St. Clair Smith, U. S. N. Introducing the subject of "intracoastal waterways" as referring to various plans, schemes and suggestions to connect certain of our coastwise cities by inland canals for the transportation of freight principally, the author of this article points out that the time is closely upon us when water transportation will inevitably come here as it has in Europe. A brief outline of the advantages gained in such cases as the utilization of the Great Lakes as an avenue of commerce, and the Sault Ste. Marie Canal, together with a few statistics from the census report of 1904 concerning the industries in the Atlantic States, is more than convincing enough to show the soundness of the business judgment that has resulted in the construction of the Cape Cod Canal. This canal, it is pointed out, was the most serious attempt in many years at a commercial canal in this country, and the locality has always seemingly offered the greatest advantages for the least effort. As early as 1697 the General Court of Massachusetts appointed a committee to survey a route across the neck of land separating Cape Cod and Buzzard's Bay. From that time until the present day the matter has been under consideration either by the government, shipowners or by capitalists. The distance is but eight miles and the surface is low. Although various attempts have been made and no serious engineering difficulties met with, the enterprise was never completed until the present company formed in 1907, and, headed by Mr. August Belmont, began operations. A stone jetty 3,000 feet long has been built to protect the northern entrance of the canal, which is 30 miles in a southerly direction from Boston. The canal prism is a cut which is at first to have a depth of 25 feet, with a bottom width of 100 feet in the narrowest parts. The northern approach has a bottom width of from 200 to 300 feet for a distance of 7,000 feet and the southern approach has a bottom width of 200 feet for a considerable distance. There are two points of passage in the canal itself where the width is 250 feet. The saving for vessels ordinarily taking the outside route—i. e., through Vineyard Sound but around Cape Cod to Boston—from all southern ports is about 60 nautical miles, while for those going around the Nantucket South Shoal Lightship it is 144 miles. The author, however, by a brief description shows clearly that there will be a much greater saving due to the curious differences in the weather conditions of the two localities. In concluding the article the author presents some astonishing figures comparing the carrying capacity of canals and railroads in general from a commercial standpoint, in which canals are many times greater than the railroads. By a similar comparison these advantages are shown to be even greater from a military standpoint in times of war, not only for transportation purposes, but, as is well known by naval men, such a canal up and down our east coast is a military asset of great and undisputed value. 1 illustration. 3,700 words.—*United States Naval Institute Proceedings,* May-June.

Operation and Trials of the U. S. Fleet Collier Jupiter.—By Lieutenant S. M. Robinson, U. S. N. A previous description of the *Jupiter* included the methods of operation at the time the dock trials were held. Since then extensive trials have been held and these methods somewhat modified, shortening the time of reversing. For that reason the author of this article describes the method of operation, and, briefly, the system of interlocks on the switches. The change on the switches is briefly described, followed by an outline of the three general methods of operation under different conditions. To explain clearly the object of the resistances, as used, a set of curves illustrates the torque on speed for the *Jupiter's* motors with resistance in and out. It is seen from these curves that the torque of the low resistance condition is very low for both backing and starting, while for the high resistance condition the torque is nearly maximum for both starting and backing. A description of the method of getting under way on the *Jupiter* shows that the method is very similar to that of other ships. The maneuvering qualities of the electric drive, it is claimed, have proved highly satisfactory, and the advantages claimed for it certainly overbalance the disadvantages. Standardization trials of the *Jupiter* held at Santa Barbara are completely summarized, with resultant curves showing revolutions, shaft horsepower and percent slip plotted on knots. Pre-

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vious to the trial, which included seventeen runs, a 48-hour high-speed trial was run on the way to Santa Barbara. The data for this trial and the 24-hour run, started immediately after standardization, are included in a table of trial data. On the 48-hour high-speed run the average speed maintained was 14.99 knots, the water rate 11.68, which is 10.15 percent better than the guarantee, and the coal consumption per day at this speed 127.39 tons. On the 24-hour endurance run at 10 knots the water rate was 12.32 pounds per shaft horsepower, which is 18 percent better than the guarantee, and the coal consumption per day 54.08 tons. Before summing up the case of the electric drive the author gives data in the form of curves obtained at the factory in Schenectady, showing water rates for 6 and 9 stage turbines plotted on kilowatts, and also curves obtained in the factory for the motors. In summing up the author concludes that the electric drive seems well adapted to ships of 5,000 horsepower and above. Undoubtedly the ideal place for it is on a battleship, and in this connection about a dozen important advantages are given which tend to verify the conclusion. 5 illustrations. 4,700 words.—*Journal of the American Society of Naval Engineers,* May.

The Sidewheel Tugboat France.—The article gives an account of the effort of a French company at Lyon to improve the shipping traffic between Lyon and the Mediterranean, for which were constructed three sidewheel tugs, two propeller tugs and thirty-six tow boats. The three sidewheel tugs were constructed by Escher, Wyss & Co., of Zurich, Switzerland, to fulfill the difficult task of going over the rapids without subdivision of the tow. The *France* is the first of these, of the dimensions 236.2 feet by 28.2 feet by 10.2 feet by 3.45 feet draft, with a diagonally inclined compound engine 30¾ inches by 53½ inches by 70⅞ inches stroke, driving two paddle wheels 14 feet 10 inches diameter by 8 feet 2½ inches wide each. The two fire rooms contain four Scotch boilers each with two corrugated furnaces and 1,400 square feet heating surface and a superheater of 269 square feet of the large flue type. The condensing plant of the jet type and the pumps and other auxiliaries are described, as well as one of the steel tow barges 255.9 feet by 25.9 feet by 8.2 feet by 5.9 feet draft, carrying 615 tons cargo. The trial trips are stated to have shown about 1,170 indicated horsepower at 38 revolutions per minute, with 173 pounds pressure on the boilers, a superheated steam temperature of 505 degrees F. and a vacuum of 24 inches. Under these conditions the coal consumption is given as 1.61 pounds per indicated horsepower per hour. In actual service the whole trip of about 170 miles was made in 48 hours, exceeding the requirements by about 25 percent. 14 illustrations. 1,850 words.—*Schiffbau,* July 22.

School Motor Sailship Great Duke Friedrich August.—Mention is made of the activity of the German schoolship society to train able seamen in sailships, of which this ship is the third. Built by the firm of Joh. C. Tecklenborg Company, in Bremerhaven, she is rigged as a bark and fitted with a 600 horsepower two-cycle crude oil engine of the Carels type. With dimensions 249.4 feet by 41.6 feet by 24 feet by 17 feet draft, she displaces 2,350 tons and measures 1,700 gross tons. The hull is built of steel to the highest class of the Germanic Lloyd fitted with six transverse watertight bulkheads, and has two continous decks, a long poop, forecastle and deckhouse with accommodations for 14 officers and passengers, about 200 apprentices, 20 petty officers and stewards and about 40 seamen. Aside from the propelling engine, a donkey boiler of 215.2 square feet heating surface for 100 pounds pressure is provided for steam pumps, winches and heating. Stowage is provided for 60 tons coal, 22 tons fresh water and 100 tons fuel oil. The boat equipment consists of ten boats, one with motor, and one punt. To carry her rig of about 21,500 square feet of sail more effectively 500 tons of ballast have been stowed below. The main masts and spars are of steel with galvanized steel standing and steel wire and manila running rigging. The propelling motor of the four-cylinder, two-cycle, single-acting crude oil type resembles a marine steam engine in the bed plate, columns, shafting, etc. The engine is simple, with scavenging slots in the cylinder walls opposite of the exhaust slots. Pistons and cylinders are cooled with sea water. The oil auxiliaries are one 30-horsepower compressor and one 12-horsepower dynamo. The total weight of the 600 horsepower engine plant is given as 115 tons. 6 plates. 5 illustrations. 4,500 words.—*Schiffbau,* July 8.

The Injector Air Pump of Westinghouse Leblanc.—After pointing out the great importance and influence of condensation upon the economy of turbine plants, mention is made of the modern tendency to replace piston air pumps by rotating injector principle air pumps of the dry air type. After discussing the characteristics of fully and partially charged rotating pumps, it is said that for large air volumes an additional jet of steam is often employed in the manner of the Parsons augmenter. A considerable improvement over this is stated to be the newly designed injector air pump of Leblanc. The characteristic features of this new form are: a subdivision of the working jet into two stages each of a number of small units in different heights to facilitate the mixture of the air with the escaping steam, and an automatic air cushion of annular form which regulates the area of the mouth of the diffuser nozzle to the requirements of starting or running conditions. It is stated that in an electric power station in Paris one of the jet air pumps was tested against a rotary pump, each producing a vacuum of nearly 29 inches with a steam consumption of about one percent of the full power consumption of the turbine. Another test on the French torpedo destroyer *Bontefeu* showed at low powers an economy of oil consumption of about 16½ percent. The principal advantages are given as: No moving parts, high efficiency, small space required, and no repairs. 12 illustrations. 3,050 words.—*Schiffbau,* July 8.

Ships with Diesel Engines of the Mercantile and Naval Service. II.—This article is concluding tabular records with notes on Diesel engine ships up to July, 1914. Table II deals with oil tankers, of which 48 are more or less completely detailed in regard to size of hulls, displacement, register tonnage, cargo capacity, speed, builders, type and size of engine, as well as power. A number of the important ships have special notes on trial trips, oil consumption, steam or oil auxiliaries, engine weights and reduction of crew over steam requirements. Table III deals in similar manner with 27 tugboats and Table IV with 33 sail ships, fishing vessels and other ships of miscellaneous classification. Table V is devoted to 55 vessels of the naval service of various governments, including submarines, torpedo boats, gunboats and launches. Table VI is given to 72 engines for miscellaneous vessels not mentioned in the five previous tables. Finally, such additional notes are given of vessels in Table I as became known on more recent dates of trial trips, auxiliaries, mishaps, fuel consumption, decrease of crew, cargo capacities on actual runs. 5 tables. 6,150 words.—*Schiffbau,* July 8.

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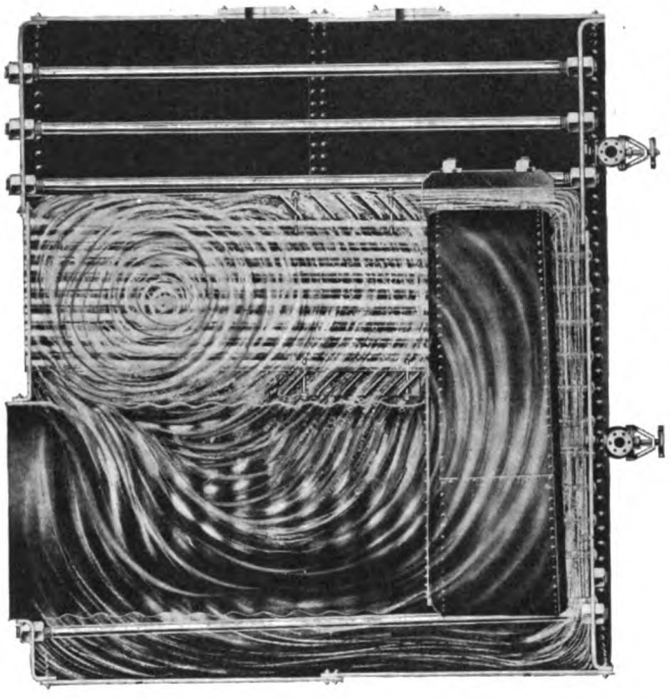
ENGINEERING SPECIALTIES

The McNab Cascade Boiler Circulator and Fuel Economizer

The most serious drawback to a Scotch boiler is the lack of perfect circulation. On account of this, dead-water is usually found below the fire grates and, what is still more important, certain surfaces exposed to the flame or gases inside the boiler, which ordinarily should be counted as heating surface, prove ineffective as a heating surface. An example of this is the combustion chamber



tube plate, which is installed in a vertical position in order to accommodate the tubes, and is exposed to the full force of the flame and gases within the combustion chamber. Without positive circulation around the tube plate the steam containing bubbles generated on the furnace crowns ascends rapidly in a direct vertical line toward the steam space, and these bubbles, rising vertically in front of the tube plate, insulate the plate and prevent its coming in direct contact with the water. This insulation is considered by many to be the direct cause of the tube plate becoming overheated, of the heavy scale and blister formation usually found adhering to its surface, and of the general deterioration of the tubes adjoining the plate.

To overcome this drawback, the McNab Company, Bridgeport, Conn., has placed on the market the "Cascade" boiler circulator and fuel economizer, illustrated on this page. This device consists of a series of diaphragm deflecting vanes inclined at an angle of 45 degrees towards the tube plate, installed above each furnace and extending 36 inches from the combustion-chamber front. The rapid current caused by the rise of steam containing bubbles generated on the furnace crowns comes in direct contact with the inclined diaphragm vanes, which deflect the current at an incline toward the tube plate, and also force a much heavier body of water to flow through the hottest parts of the tubes near the tube plate. The water impinged at an angle against the tube plate, it is claimed, washes off the bubbles and prevents insulation, converting this plate into an efficient heating surface.

The circulation throughout the boiler is caused by the diaphragm generating vanes installed on the top row of tubes. The rapidity of the upper current is greatly accentuated by the additional heat imparted to the water through coming in contact with the hot tube plate, and this current is deflected above the tubes in such a manner as to create a longitudinal circulation. While the circulation at the bottom of the boiler is positive, it is not of sufficient force to drive the heavier foreign substances, such as mud, sediment, etc., toward the surface.

The McNab "Cascade" circulator is easily installed without cutting or mutilating the boiler in any way. The largest parts of the circulator will readily pass through an ordinary manhole, and the vanes are held in place by 5/8-inch hook bolts attached to the outer tubes. By loosening the hook-bolts they can be readily shifted to the front end of the boiler to permit cleaning or internal inspection.

Electrically Lighted Launches and Tug Boats

A simple, reliable and efficient method of lighting steam launches by electricity has been developed by the Westinghouse Machine Company, East Pittsburg, Pa., which has placed on the market for this purpose a small, compact turbo-generator of 1 kilowatt capacity. At a speed

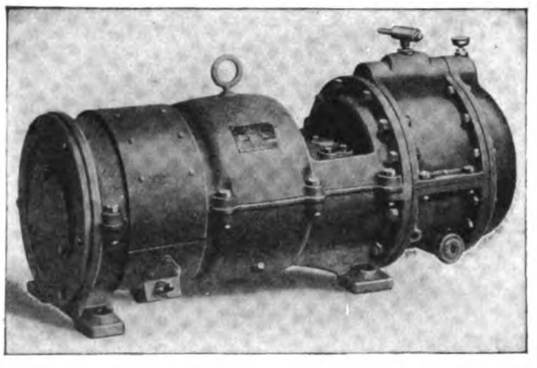


Fig. 1.—Westinghouse 1 Kilowatt Turbo Generator

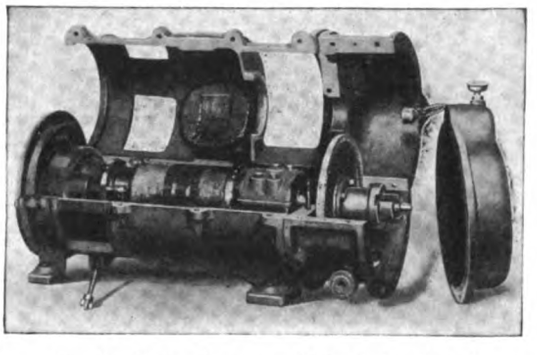


Fig. 2.—Turbo Generator With Casing Raised

of 4,000 revolutions per minute this outfit develops sufficient current at 120 volts to supply forty 25-watt lamps. It weighs only 400 pounds, is 35 inches long, 17 inches high and 14 inches wide. At full load it uses about 160 pounds of steam per hour.

In the design of this set reliability was the first consideration. The turbine and armature are mounted on a single shaft with a governor at the end of the shaft controlling the amount of steam admitted to the turbine.

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There are no delicate adjustments to be made. Every part is easily accessible for inspection, and the machine can be installed by the ship's force and operated with very little attention. Large bearings, lined with the best grade of babbitt, are automatically lubricated by oil rings from reservoirs which require refilling only once in several months. The governor, it is claimed, keeps the speed uniform for all ordinary variations of load and steam pressure. At 90 pounds steam pressure the turbine will develop full rating, although it is suitable for pressures up to 250 pounds per square inch.

Six of these units have recently been installed for lighting the steam launches of the Argentine battleships *Moreno* and *Rivadavia*.

An Achievement in Marine Refrigeration

On July 6 the United States Government awarded a contract to the Shipley Construction & Supply Company, Brooklyn, N. Y., agents for the York Manufacturing Company, York, Pa., to install on the United States transport *McClellan*, at Erie Basin, Brooklyn, a 35-ton York steam-driven refrigeration machine. The contract called for completion of the work (under forfeit) in ten days, and included, besides the installation of new work, changes to system already in operation. As a matter of fact, steam was given to the machine and brine lowered from 35 degrees F. to — 4 degrees F. in less than nine days.

Besides installing the equipment mentioned above, the contractors disconnected the brine coolers already in operation, changed their position to make room for the new machine, and connected up the complete plant to work interchangeably with a machine already installed. This installation was made to serve a number of compartments in which will be carried, with other perishable foodstuffs, frozen beef to troops at tropical stations.

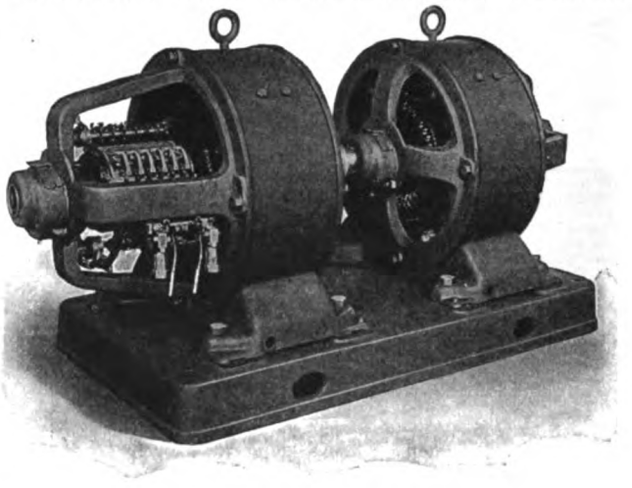
The equipment installed consists of a 35-ton horizontal double-acting ammonia compressor, driven by a 13½-inch by 24-inch horizontal engine. The compressor is of the newest "hog back" type, in which the water jacket, ammonia cylinder and crosshead barrel are connected by a single casting instead of by tie-rods. The condensers are of the "Shipley" flooded type, which it is claimed are more efficient and at the same time occupy less space than the regular style of ammonia condenser. The whole outfit, exclusive of pipe connections, weighs in the neighborhood of 18 tons.

All the piping used was cut and tested under water at 300 pounds pressure at the shop of the Shipley Construction & Supply Company, before going aboard the *McClellan*. Only genuine wrought iron pipe was used, and litharge and glycerine flanged joints were made on all ammonia connections.

Westinghouse Arc Welding Apparatus

Realizing from past experience the practical value of the electric arc for general welding purposes, the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., has developed a standard line of electric arc welding equipments. The equipments comprise standard apparatus. They are simple in construction and easy to operate. Complicated relay schemes for automatically inserting resistances are eliminated. Ample protection is secured, it is claimed, by circuit breakers and special arrangement of the resistance. The outfits are furnished complete in the four following sizes: 200, 300, 500 and 800 amperes.

Each equipment includes a welding generator, or a welding motor-generator set, switchboard, control and all necessary accessories. The welding generator consists of a special 75-volt, commutating-pole, direct-current machine, either belt or motor-driven. The instrument and control panels are composed of two sections. The upper section contains the indicating instruments, protective apparatus and switches arranged for regulating the welding current, and the lower section contains the starting and protective equipment for the motor-generator set. It is often desired to have several welding circuits connected



Welding Motor-Generator Set

to one generator. For this arrangement a control panel is provided for each circuit. Each panel can be located at the most desirable place. Metal or carbon pencil welding can be done from any of these panels independent of all others, and one or more arcs can be operated simultaneously.

The accessories furnished consist of a carbon holder and a hood for protecting the operator, together with a shield and a metal holder for each welding circuit.

Lloyd's Wreck Statistics for 1913

The statistical summary of vessels totally lost, broken up, condemned, etc., now published by Lloyd's Register, shows that, during 1913, the gross reduction in the effective mercantile marine of the world amounted to 665 vessels of 717,030 tons, excluding all vessels of less than 100 tons. Of this total, 371 vessels of 533,002 tons were steamers, and 294 of 184,028 tons were sailing vessels.

These figures, as regards steamers, are lower than those for 1912 by 39,743 tons; but as regards sailing vessels, they are for the year 1913 somewhat higher, viz., by 7,808 tons.

One of the most common terminations of a vessel's career is by breaking up, dismantling, etc. (not in consequence of casualty). The amount of tonnage so dealt with in 1913 was 108,795 tons, this being 48,846 tons less than that for 1912. Nearly 20½ percent of the steamers and 16 percent of the sailing vessels removed from the merchant fleets of the world in the course of 1913 are accounted for in this manner. Of the total tonnage of such cases 42¾ percent is represented by United Kingdom vessels.

Strandings and kindred casualties which are comprised under the term "wrecked," are much the most prolific cause of disaster. To such casualities are attributable over 58½ percent of the losses of steamers, and over 54 percent of sailing vessels. Cases of abandoned, foundered, and missing vessels are no doubt frequently more or less similar in the circumstance of loss. If these be taken collectively, they form about 21¾ percent of the steamers, and over 29 percent of the sailing vessels removed from the mercantile marine during 1913, owing to casualty.

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Personal

John Maloy, of Rensselaer, N. Y., is chief engineer of the towing steamer *Victoria,* of New York harbor.

Paul Revers Smith, cadet engineer in the United States Revenue Cutter Service, has been appointed third lieutenant engineer.

Aaron Matheis, cadet engineer in the United States Revenue Cutter Service, has been appointed third lieutenant engineer.

Chester Arthur Beckley, cadet engineer in the United States Revenue Cutter Service, has been appointed third lieutenant engineer.

Isaac John van Kammer, cadet engineer in the United States Revenue Cutter Service, has been appointed third lieutenant engineer.

John P. Bean, formerly with the Mississippi Dredge Fleet, has been appointed chief engineer of the new Arkansas River dredge *H. S. Tabor.*

James Bullock, first assistant engineer of the *Mongolia,* will act as chief engineer of the vessel, relieving the chief engineer, Robert Paul, temporarily.

Arthur Phillips, formerly with the Mississippi Dredge Fleet, has been apointed first assistant engineer on the Arkansas River dredge, *H. S. Tabor.*

Leonard Alling, engineer for the New England Steamship Company, has accepted a position as engineer on the steamer *Rowe,* of New Haven, Conn.

William Fairbrother, formerly chief engineer of the *Greenport,* has been transferred to the *Frank Jones,* of the Hudson Navigation Company, New York.

Michael Dugan has been appointed chief engineer of the steamer *Angler,* which is in service on the Potomac River, to take the place of Merril Marden, resigned.

Benjamin Free, chief engineer of the *City of Sidney,* of the Pacific Mail Steamship Company, San Francisco, Cal., has been appointed assistant to William Chisholm, superintendent.

Frank Smith, engineer of the *John Seeley,* of the Seaboard Equipment Company, New York, has been appointed engineer on the steamer *William M. Merwin,* of Milford, Conn.

John Barratt, formerly first assistant engineer on the *Nile,* of the Pacific Mail Steamship Company, San Francisco, Cal., has been appointed chief engineer of the *Peru,* of the same company.

William Lovell, formerly first assistant engineer of the *Bear,* has been appointed superintendent engineer of the San Francisco & Portland Steamship Company, with headquarters at Portland, Ore.

E. K. Morgan has been promoted from the position of foreman to superintendent of the Rockford Drilling Machine Company, Rockford, Ill. Mr. Morgan succeeds John S. Langwill, lately deceased.

Henry Hunt is chief engineer of the night crew on the tow-boat *George N. Southwick,* of the Great Lakes Dredging & Towing Company. Captain Melvin van Steenburg is in command of the boat.

W. L. Martignoni has been appointed chief engineer of the *George W. Elder,* of the North Pacific Steamship Company, San Francisco, Cal. The *Elder* has recently been completely overhauled and rebuilt.

Jesse W. Reno was awarded recently by the city of Philadelphia, acting on the recommendation of the Franklin Institute, a John Scott legacy medal and premium for the escalator of which he is the inventor.

George W. Morey has been appointed chief engineer, with Deacon Wiseman in command, of the tug *Julia A. Brainard,* for "northern canal" work between Troy, N. Y., and the State Dam, just above Waterford, N. Y.

John W. Allardice, formerly first assistant engineer on the *C. W. Morse,* has been appointed chief engineer of the *Greenport,* of the Hudson Navigation Company, New York, with Paul Maltais as first assistant engineer.

Ambrose van Wie has been apointed chief engineer on the night crew of the tow-boat *William Kinch,* of the Great Lakes Dredging & Towing Company, Detroit, Mich. Captain George S. Walker is in command of the tug.

John Daly has been appointed chief engineer of the United States tug *General Totten,* which is in service on the Hudson River above the State Dam at Waterford, N. Y. Captain George Trei is in command of the boat.

James H. Jenkins, of Stamford, Conn., has been elected to succeed Joseph C. Whitney as president of the Merchants' & Miners' Transportation Company. Mr. Whitney has been with the company since he was eighteen years old.

L. Rickinson, formerly consulting engineer to Messrs. Jacobs & Barringer, of London, will accompany the Imperial Transantarctic expedition as chief engineer of the *Endurance.* Mr. Rickinson is a member of the Society of Marine Engineers.

Felix Nash, who has formerly served as engineer with the Great Lakes Dredging & Towing Company, and also with the Hudson Navigation Company, New York, has been appointed first assistant engineer of the steamer *C. W. Morse,* of the latter company.

Robert Burk, formerly of the Homegardner sandsucker *Alice M. Gill,* has been appointed chief engineer of the tug *Yale* of the Great Lakes Towing Company, succeeding the late Fred Koombs, who died as a result of scalds received from the bursting of a throttle valve on the *Yale.*

John Seemen, formerly of the sandsucker *Kelley's Island,* has been appointed engineer of the *Alice M. Gill.*

Herbert Sharp has been promoted from the sandsucker *Clinton* of the Kelley's Island Lime & Transportation Company to the post of chief engineer of the *Kelley's Island* of the same company.

August Schenk, formerly of the steamer *Edward Recor,* of the Kelley's Island Lime & Transportation Company, has been promoted to the sandsucker *Clinton* of that company.

John Guckert, formerly assistant engineer of the steamer *Albert Y. Gowen,* of the Kelley's Island Lime & Transportation Company, has been promoted to the position of chief engineer of the steamer *Edward Recor* of the same company.

Obituary

John P. Holland, inventor of the submarine boat, died on August 12, at his home in Newark, N. J., from a severe attack of pneumonia. Mr. Holland was seventy-one years of age and leaves a wife, three sons and a daughter. Mr. Holland first began to think seriously of a submarine boat while in Europe when the news came of the battle between the *Monitor* and the *Merrimac.* From that time until 1898, when a submarine torpedo boat constructed by him was tested successfully in New York harbor before a committee of Government representatives, Mr. Holland devoted his entire time and energy to the development of this type of boat.

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SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,100,705. DEVICE FOR STEADYING SHIPS. THOMAS C. FORBES, OF LOS ANGELES, CAL., ASSIGNOR, BY MESNE ASSIGNMENTS, TO SPERRY GYROSCOPE COMPANY, A CORPORATION OF NEW YORK.

Claim 3.—The combination with a body of a steadying device comprising, a fly-wheel support mounted to oscillate through wide angles on an axis lying generally in the plane of motion to be counteracted, a fly-wheel of relatively smaller weight than that of the body journaled in said support with its axis extending transversely of the axis of said support and transverse to the axis of said body, means for tending to hold the fly-wheel in the mid position of its oscillation and means for rotating said fly-wheel whereby the gyroscopic reaction of the oscillating support directly steadies the body. Thirteen claims.

1,099,998. SUBMARINE SIGNALING APPARATUS. JOSEF SCHIESSLER, OF BADEN, NEAR VIENNA, AUSTRIA-HUNGARY

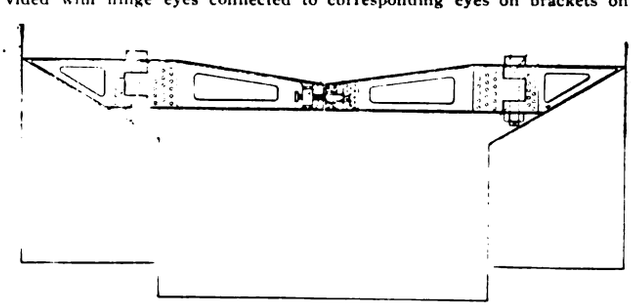
Claim 8.—In a signaling apparatus, a submarine sound receiver, an electric circuit containing two adjustable windings, a core common to both of them, and an incandescent winding adjacent said receiver, an independent amplifying circuit containing a winding on said core, an adjustable condenser and adjustable resistance and an incondescible resistance cooled by a current of air across said circuit and in parallel with the condenser and adjustable resistance, a telephone circuit including a telephone, in inductive relation to the amplifying circuit, a tuning fork in proximity to the telephone, a clock, and mechansm operated by the tuning fork to stop the clock. Eight claims.

1,100,954. OUTBOARD MOTOR-SUPPORT. AUGUSTE ARTHUR CAILLE, OF DETROIT, MICH.

Claim 1.—In combination with a boat having a pointed stern, a deck carried thereby, a bracket secured to the deck, a pair of gripping members each adapted to engage with one side of the end of the boat, an outboard motor support carried by the gripping members, and means connected to the bracket on the deck, whereby the gripping members may be brought into engagement with the side of the boat. Ten claims.

11867/1913. PORTABLE CROSS-BEAM FOR SHIPS. J. R. WIGHAM, OF 4, VALEBROOK GARDENS, SUNDERLAND, AND G. H. JOHNSON.

Claim.—According to this invention portable cross-beams for ships are constructed in two halves or members of steel, preferably in the form of girders, the outer ends being larger than the inner ends, and provided with hinge eyes connected to corresponding eyes on brackets on



the ship's frame by a bolt, to form a hinge joint at each end of the members so that they can each be swung round to open or to close the beam, stops being provided to limit the extent of opening. For securing the inner ends two swivel nuts on one member are engaged by screw-threaded bolts sufficiently long to engage in housings on the other member.

5763/1913. ELECTRICALLY GOVERNING THE SPEED OF ENGINES AT SEA. A. W. FITHIAN, 59, HARROGATE ROAD, CHAPEL ALLERTON, LEEDS.

Claim.—By means of a gravity controlled rheostat the current passing round the winding of an electro magnet, the core of which is attached to the moving portion of a balanced throttle valve, is varied gradually by the motion of the ship causing the throttle valve to close and open gradually according to the variation of load imposed on the engine due to whether the propeller is entirely immersed in the water or not, thus causing the engine to run at more or less a constant speed.

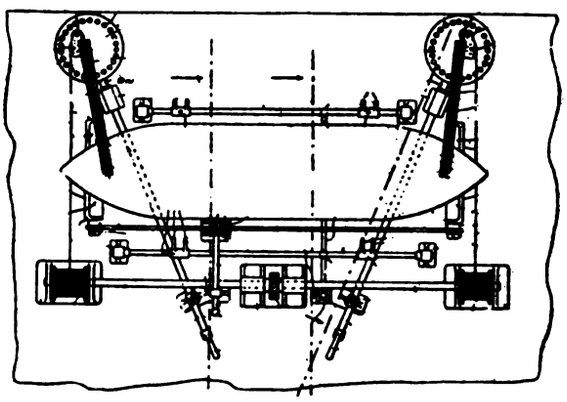
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

1505/1913. ELECTRICALLY OPERATED STEERING GEAR. THE BRITISH THOMSON-HOUSTON COMPANY, LTD., OF 83 CANNON STREET, LONDON, E. C.

Claim.—Mechanism for operating ship's steering gear or the like comprises the following elements: A controller adapted to be operated by the steering wheel through differential gearing, a motor adapted to operate the rudder or other device, and to return the controller to its "off" position, the motor being supplied with current from a motor generator set, the field of which is varied by means of a rheostat whose arm is operated from the shaft of the motor generator set. The circuit of the field and rheostat are completed when the controller is moved from its "off" position. An electro-magnetic clutch is adapted to connect the rheostat arm with the shaft of the motor generator set when the controller is moved from the "off" position, and a switch opens the circuit of the clutch when the arm has reached the limit of its travel, a magnet retaining the arm in this position until the controller is reurned to its "off" position.

6524/1913. SHIP'S BOAT RAISING AND LOWERING GEAR. T. A. SCOTT, 15 FAIRFIELD ROAD, SUNDRIDGE PARK, BROMLEY, W. KENT.

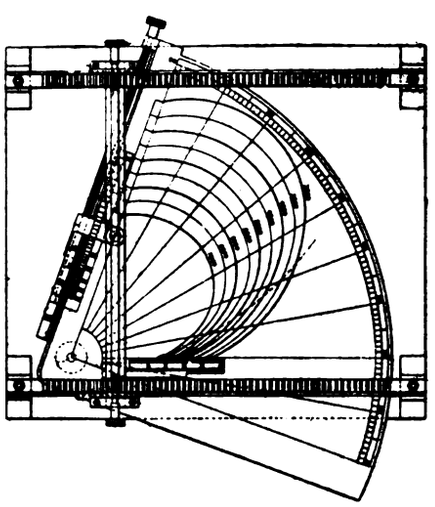
Claim.—A boat raising and lowering gear comprises the following elements in combination: Davits with mechanism for positively and independently turning them about their perpendicular axes, fall-drums



with mechanism for operating them independently of the davits, pivoted chocks with means for simultaneously turning them to, and maintaining them in, the upright or operable position and turning them therefrom to free the boat, and gripes with mechanism for simultaneously engaging and disengaging them, the whole being arranged in such manner that the primary or initial elements of the respective operating mechanisms are assembled midway between the davits to provide a central point of control or operating station.

11,283/1913. INSTRUMENT FOR INDICATING THE RIGHTING ARMS AND OTHER PARTICULARS RELATING TO THE STABILITY OF SHIPS. S. B. ROLSTON OF 11 BOWLING GREEN, WHITEINCH, GLASGOW, SCOTLAND.

Claim.—This is an instrument for indicating the righting arms and other particulars relating to the stability of ships, comprising a plan of curves plotted to indicate the B. R. for various displacements of a vessel, an indicating pin the position of which shows the centre of gravity of a vessel and which can be adjusted in position relatively to the plan



of curves, and a bar or the equivalent for use in conjunction with the pin and mechanism for effecting relative movement between the plan of curves and the bar such that the latter at all times represents a vertical drawn through the center of gravity of the ship. The plan of curves is in the form of a pivoted graduated quadrant upon which the pin is adjustably mounted, a slotted bar being engaged by the pin and being caused to move in a parallel direction whilst the quadrant is movable in an angular path.

2,837/1913. A HYDRO-MECHANICAL STEERING APPARATUS FOR SHIPS. J. PATTERSON, OF SCOTIA ENGINE WORKS, 130 ELLIOT STREET, GLASGOW, N. B.

Claim.—Ships' steering apparatus made according to this invention comprises the following elements: A constantly-running constant delivery, mechanically-operated pump of any convenient form, a system of valves controlling the direction of flow from that pump alternatively to a storage tank and to hydraulic cylinders operating the rudder, a friction clutch device, operated by the usual hunting gear, such and so operatively connected between a constantly-running shaft and the valve system that it causes the valves of the system to be moved oppositely as the hunting gear moves oppositely from mid-position, and means for permitting the continued movement of the hunting gear away from mid-position after it has moved the friction clutch into engagement in one or other direction. One claim.

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